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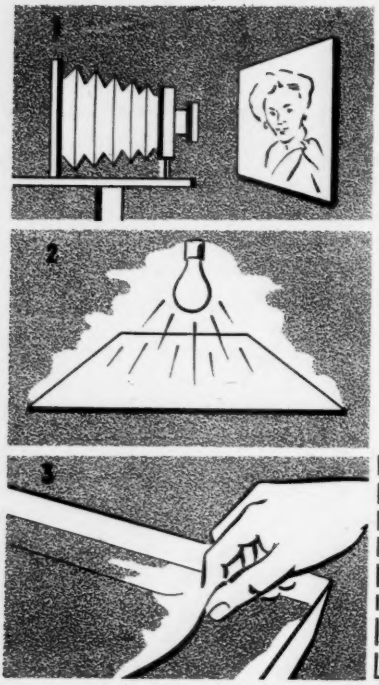

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THE COLONIAL DEVELOPMENT CORPORATION

THE annual report of the Colonial Development Corporation for the year ended December 31, 1955*, is cast in the staccato form that has characterized the report since Lord Reith assumed the chairmanship of the Corporation; but this year, for the first time, the accounts show a surplus of £409,233 after paying all outgoings, including £307,000 Colonial Office interest.

Ten new projects were initiated by the Colonial Development Corporation during the year, and, with the completion of the Barton Ramie and Murongo investigations, and the appointment of a receiver for the Falkland Islands Freezer Co., Ltd., there are sixty-three continuing projects and investigations compared with fifty-six in the previous year, representing a total capital of £54·8 million. Of these projects, eighteen, representing £7·5 million, are in the Caribbean; seven (£15·4 million) in the Far East; thirteen (£13 million) in East Africa; six (£6 million) in Central Africa; eleven (£9·86 million) in the High Commission Territories; and eight (£2·9 million) in West Africa. Functionally, twelve projects and 20 per cent of deployed capital at December 31, 1955, were in agriculture; six and 5·4 per cent in animal products; six and 6·9 per cent in factories; one and 0·3 per cent in fisheries; five and 12 per cent in forestry; one and 0·7 per cent in hotels; ten and 13 per cent in minerals; seven and 10·9 per cent in property and housing; six and 26·3 per cent in power; and eight and 4·5 per cent in transport and communications.

On direct projects and subsidiary companies, the Corporation had a net operating profit of £113,165 during the year, in spite of the disappearance of Chilanga profits of £216,718 in 1954 with the sale of the Corporation's controlling influence from January 1, 1955. The 'redding-up process' is now virtually completed, and the Corporation by and large is free to devote its energies to constructive purposes involving normal commercial or calculated risks. The 'Special Losses' were assessed on December 31, 1955, at some £8 million, and it is clear that the Government must now face the outstanding financial issues involved in dealing with these losses incurred before the Corporation was built up. The Corporation proposes to disregard this Special Losses Account in adjusting its policies to meet the requirement of the Overseas Resources Development Act that it should pay its way taking one year with another, and it now suggests that the whole of this Account—not merely a part—should be accepted as eligible for interest waiver, and that this should be done by converting the £8 million into equity capital in accordance with the precedence of the International Bank for Reconstruction and Development and the International Finance Corporation.

This is not the only way in which the Government could help to promote a more vigorous policy, nor is it the only point at which there is a clash between the Corporation and the official view. The latter has interpreted the Overseas Resources Development Act so as to make *ultra vires* several projects for housing and road development in Singapore and Malaya, Kenya, Nyasaland, Southern and Northern Rhodesia and West Africa, involving more than £7·5 million; but on legal advice the Corporation has declined to accept the official legal view, and awaits the validating and enabling legislation promised by the Secretary of State. The Corporation in this report also points to the desirability of co-ordinating its funds with Colonial Development and Welfare Funds, suggesting that the Government might meet essential but financially unremunerative projects, leaving the remainder to the Corporation and its partners. Only exceptionally should the Corporation undertake work of great potential benefit but doubtful profitability.

In spite of its staccato phrases, the report is thus a challenge to realistic thinking and planning of such resources as Britain is able to devote to the economic development of the dependent territories of the British Commonwealth. It is the duty of the Colonial Development Corporation to assist such development and with special regard to the interests of the inhabitants of those territories. The Corporation is not, however, responsible for comprehensive planning, or for social services such as health and education. These, the report suggests with reason, are, or should be, financed from Colonial Development and Welfare Funds or other government funds. Similarly, government plans should include such services as power, communications and housing. The Corporation's terms of reference are commercial, and profitability is a decisive factor in the selection of projects and the method of executing them. The Corporation should only be expected to help in the capital development of basic services when no other means of finance is available.

The formulation and acceptance of clearly defined policies on such lines would go far to establish the Corporation on a satisfactory commercial basis; but more important, it would provide the Corporation with the assurance of continuity which it seeks, and the clear definition of fields of work which are as essential for harmonious co-operation as they are for preventing wasted effort and overlapping. As is well emphasized, development in the dependent territories of the British Commonwealth is always a dynamic process in which social conditions and agricultural and industrial techniques are continually changing. The report points out that the tropical territories in which the Corporation mostly operates can scarcely look forward to more favourable economic conditions than in 1955. The Corporation itself benefited from the high prices of rubber and improved prices for hardwoods, but the two copper projects will not start producing until late in the present year. Prices of other Corporation products, such as hemp, rice,

* Colonial Development Corporation. Annual Report and Statement of Accounts for Year to 31.12.55. Pp. v+55. (London: H.M. Stationery Office, 1956.) 2*s.* 6*d.* net.

hide and bananas, tended to drop, and synthetic substitutes are threatening raw materials traditionally grown in the tropics, among which the Corporation is directly interested in rubber, hemp, tung oil, and, through tanning materials, in leather, though its interest in ramie has ceased. Moreover, the production of foodstuffs in developed countries can be so increased by application of fertilizers and use of mechanical equipment as to undercut producers in less-developed and more remote lands.

These are all factors of which the Corporation must take account in attempting to assess the profitability of projects in ten or twenty years time, and in selecting projects accordingly. Increasing association with local people in such projects through smallholding and co-operative schemes will not make decisions easier; but the Government, by taking the financial decisions suggested above and by delineating more carefully the spheres of responsibility, could undoubtedly help the Corporation to raise the standard of living in these areas. Even more directly, Government policy could contribute to provide assured markets for the efficient grower of tropical produce; and the dissolution of the Overseas Food Corporation on March 31, 1955, places even greater responsibility in this connexion on both the Colonial Office and the Tanganyika and other African Governments.

CHEMISTRY AND BIOCHEMISTRY OF FATS

The Lipids

Their Chemistry and Biochemistry. By Prof. Harry J. Deuel, Jr., Vol. 2: Biochemistry—Digestion, Absorption, Transport and Storage. Pp. xxvi+919. (New York: Interscience Publishers, Inc.; London: Interscience Publishers Ltd., 1955.) 25 dollars.

Fat Metabolism

A Symposium on the Clinical and Biochemical Aspects of Fat Utilization in Health and Disease. Edited by Victor A. Najjar. Pp. viii+185. (Baltimore: Johns Hopkins Press; London: Oxford University Press, 1954.) 36*s*. net.

The Chemistry of Lipids of Biochemical Significance

By J. A. Lovern. (Methuen's Monographs on Biochemical Subjects.) Pp. xiii+132. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1955.) 8*s*. 6*d*. net.

THE collection of the greater part of the available information in the vast and rapidly developing field of lipid biochemistry and its integration into a readable text are a remarkable achievement. It is not, however, possible to be both comprehensive and critical over such a wide field. The late Prof. H. J. Deuel, jun., in "The Lipids: Their Chemistry and Biochemistry" (Vol. 2), chose the former course. All the main contributions on the digestion, absorption, transport and storage of lipids are recorded in this book. Where differences of opinion exist, the views of each side are clearly and fairly presented. The author was one of the most active contributors to new knowledge in this field, and he had definite views on most of the problems discussed in this work. These are indicated, but are not forcefully imposed; the reader is left to formulate his own conclusions. This is an excellent book for the more advanced student. It is likely to serve as a standard work in this field for many years.

The symposium on "Fat Metabolism", edited by V. A. Najjar, is an entirely different type of work, which consists of a series of short lectures by leading authorities. There are eleven main contributions. These include papers by H. H. Gordon and J. Mayer on obesity, and a contribution on the clinical aspects of hyperlipæmia by L. E. Holt. H. C. Meng describes the preparation and use of fat emulsions for intravenous alimentation, and the role of the lipæmia clearing factor in fat transport is considered by C. B. Anfinsen. Fatty-acid-oxidation and synthesis, lipogenesis *in vitro* and the role of coenzyme A in such reactions form the subject of three communications by A. L. Lehninger, S. Gurin and F. Lipmann, respectively. Phospholipid synthesis, by A. Kornberg, and cholesterol metabolism in relation to atherosclerosis, by R. G. Langdon, complete a remarkable collection of papers. Four contributions to discussion are also given. The only other aspect that might perhaps have been included with some advantage is the role of the intestine in fat metabolism. This book is an excellent introduction to current problems in fat metabolism, especially for those interested in the medical aspects. As will be expected, each contribution is both authoritative and lucid.

Dr. J. A. Lovern's monograph on the "Chemistry of Lipids of Biochemical Significance" is a concise account of the more important background knowledge required for biochemical studies in this field. The first chapter is concerned with the structure of lipids, a matter that is much under discussion at the present time. A useful section on separation and analysis follows, which reflects the extensive experience the author has had in this field. Having dealt with the study of separated lipids, the forms in which they occur in the tissues, with special reference to lipoproteins, and their turnover, are discussed at some length. Finally, a brief chapter on the functions of lipids concludes a record of the main features of current problems in lipid chemistry that should prove useful to any biochemist.

A. C. Frazer

POWER AND ENERGY FROM THE WINDS

The Generation of Electricity by Wind Power

By E. W. Golding. (Spon's Electrical Engineering Series.) Pp. xvi+318+28 plates. (London: E. and F. N. Spon, Ltd., 1955.) 50*s*. net.

BEFORE the industrial potentialities of nuclear fuels began to be clearly realized, the Wind Power Committee of the Electrical Research Association intensified its study of the winds as a supplementary source of synchronous electric power. An all-important impelling factor was the scarcity of coal for the generation of electricity; but importance was attached to an experiment made in the United States in which a 1,200-kW. wind-driven generator had been operated successfully in parallel with a major electricity supply system. The American wind turbine had indeed failed mechanically after a

few hundred hours of operation; but it had shown that there is no physically insurmountable obstacle in the way of developing wind-driven generators of relatively large capacity.

Denmark, France, Germany, Italy and the U.S.S.R. have also done work of great interest in assessing the energy-producing prospects of wind-power and in constructing and devising wind-driven generators. Past experience was carefully reviewed. The fact that some ten thousand corn-grinding mills had been performing a valuable function in Great Britain prior to the development of the steam engine was, and is, significant. It was estimated that there are several hundred sites in Britain which might be used for establishing wind-driven electric generators of capacities of the order of 1,000 kW. each.

The author of this book, Mr. E. W. Golding, was charged with the tasks of examining the problems of measuring and harnessing the power and energy of the winds at suitable sites. He and his staff proceeded to their work with due expedition and great enthusiasm. Precise and convenient means of measuring wind velocities over the wide range encountered in practice were developed and applied at a sufficient number of sites to obtain the data required by aerodynamic experts, the potential builders of efficient wind turbines.

It so happened that the development of helicopters, on one hand, and of jet aircraft, on the other, aroused the interest of propeller designers in the wind wheel, which promised to provide a new outlet for their factories. As a result, John Brown and Co., Ltd., produced a 100-kW. machine for the North of Scotland Hydro-electric Board which is installed on Costa Head, Orkney, while the Enfield Cable Co. produced through De Havilland (Propellers), Ltd., an Andreau machine of the same kilowatt rating for the British Electricity Authority. The latter machine is still on a temporary site near St. Albans. These two experimental installations cover almost the extreme range of types of wind wheel, electrical generating plant and wind speed conditions. At Costa Head, wind speeds approaching 100 m.p.h. are frequently encountered and it is exceptional to have periods approaching dead calm, whereas at St. Albans wind speeds seldom reach even 30 m.p.h.

No account of the performance of these plants has yet been published; but it is now doubtless possible for the responsible parties to assess, more realistically than ever before, what power and energy can be obtained from comparatively large wind-driven electric generators. The work put into these two experiments has been of the highest class in all respects. The firm of John Brown has experienced almost every practical difficulty which can be encountered, and the major burden has been borne by two resolute and competent men, as a supplement to their everyday occupations. They could give an epic account of their problems, which far surpass in difficulty those of the earlier lighthouse pioneers.

Golding's book is interesting, informative and earnest. The author has deservedly gained a leading place among the few who continue to maintain an active interest in wind-power. He provides excellent references to relevant literature from all countries. He does full justice to most of the foreign achievements; but he might have made more effective use of the highly objective studies of Electricité de France. He likewise appears to have overlooked the numerous wind machines in service on the coast of Portugal, near Lisbon. There one can see installations ranging from the original Don Quixote type to the most modern propeller types, indications of the suitability of the wind regime, on one hand, and of the local cost of electricity, on the other. Table 32 would have been far more valuable had he included the weights of materials of construction of the machine. I must, however, abstain from emulating Goethe's "Rezensent", and I therefore commend the book as being a most valuable and up-to-date source of reference.

In conclusion, I suggest that the attempt to produce large amounts of synchronous electrical power and energy from the winds is less realistic in present circumstances than a Belgian proposal to use medium- or small-power plants to generate energy partly in electrical form and partly as hot water not necessarily electrically heated. There are many farms and isolated communities which could be rendered more economic and habitable given these amenities. Production of machines of this class might be more generally useful than the procedure hitherto followed.

C. W. MARSHALL

PRINCIPLES AND APPLICATIONS OF PHYSICS

Principles and Applications of Physics

By Dr. Otto Blüh, in collaboration with Joseph Denison Elder. Pp. xiv+866. (Edinburgh and London: Oliver and Boyd, Ltd., 1955.) 45*s.* net.

BOTH in its aim, which is wider, and in its presentation of the subject, which seems more appropriate for reflexion and consolidation than for a serial course, this book differs from the conventional physics text-book. The standard is such that most of it could be understood by sixth-form boys, and it would be useful to students in the early stages of a university course in physics. The authors survey the subject as a whole, tracing the developments of the concepts of modern physics, and the interaction of new discoveries and scientific thought at different periods. This treatment should make it acceptable also to non-specialists and students of the humanities who (given some initial elementary grounding) seek a sound interpretation of physics; such readers, whom the authors have borne in mind, will find it both intelligible and in sympathy with their own outlook.

The book is divided into ten parts. Part 1, on the methods of physics, contains some introductory mathematics. Parts 2–6 deal with mechanics, energy, fields of force, oscillations and waves, and thermodynamics. Each part groups together phenomena linked by a common principle—heat, electrical energy, and radiation as forms of energy, gravitation, electrostatics, and electromagnetism as fields of force, optics and acoustics with other examples of wave motion. The authors call this a phenomenological and mathematical approach, in which formal analogies are used. They are probably right; and it is certainly done well.

Parts 7–9, on the kinetic theory, particles, and atomic and nuclear physics, offer less scope for originality of treatment, and indeed by this time the really difficult part of the work is over. In its more recent developments, physics deals either with particles that are easily pictured, or with symbols that are beyond any visualization; the apparently simple concepts of macroscopic physics are the elusive ones. Who can doubt, for example, that the

picture shown of stationary waves around Bohr orbits was really in people's minds in the early days of wave-mechanics? Or that this, in itself, is a much easier idea to understand than, say, the principle of virtual work, or even that notorious source of misunderstanding when it was first discovered, Ohm's law? In directing attention to the quite different kind of mental effort needed to master the early fundamentals, the authors have really implicitly diagnosed the fault that hinders the progress of so many students, a feeling that physics began with the twentieth century. Needless to say, the rigours of modern physics are themselves explained here very clearly.

The title might almost suggest a bias towards applied physics, but in fact only representative applications are explained at all fully. These include the circulation of the blood, thermionic valves and radio circuits, frequency modulation, three-phase power supplies, the implications of recent red-shift observations with the 200-in. reflector, and many uses of radioisotopes. The numerous brief allusions to well-known applications are relevant. Most teachers, incidentally, would treat thermometry and electrolysis rather differently nowadays.

Part 10, on the scope and importance of the physical sciences, is rather more difficult to assess. I can only say that, if I had read a book of this kind as a student, I should have realized then that philosophy is something more than the extrapolation of a classical education; and that, oddly enough, the term 'natural philosophy' means what it states. Among many issues discussed are the status of the term 'law' in the exact sciences, the fallibility of scientific method when taken beyond its proper province, and the general education of both the scientist and the non-scientist. It has been said that the way to broaden the general education of the physicist is by encouraging a thorough understanding of his subject, and its impact on people's minds and affairs. From this point of view the later chapters of the book are particularly valuable.

G. R. Noakes

LUMINESCENCE OF BIOLOGICAL SYSTEMS

The Luminescence of Biological Systems

Edited by Frank H. Johnson. (Proceedings of the Conference on Luminescence March 28–April 2, 1954, sponsored by the Committee on Photobiology of the National Academy of Sciences—National Research Council, and supported by the National Science Foundation.) Pp. xiv+452. (Washington, D.C.: American Association for the Advancement of Science, 1955.) 7 dollars.

THE production of light by many living organisms is a very striking characteristic and has been recognized since the earliest times. Pliny observed the glowing of rotting wood, Aristotle had an account of the light emitted by putrefying fish, and Boyle in 1667 examined the luminescence of stored meat. The early papers of Paul Panceri in 1873 on *Pyrosoma*, *Pholas* and *Phyllirhoë* are classics.

This book is an account of the proceedings of the conference on luminescence, held at Asilomar, Pacific Grove, Calif., during March 28–April 2, 1954, and the papers and the main discussion of each are given verbatim. The first paper, a survey of luminous organisms, is by Prof. Newton Harvey, a pioneer in this field and celebrated for his classic and extensive investigations into the subject of luminescence. This is a very lucid account of the state of the existing knowledge of the problem, with stimulating suggestions for further work. Methods are described with a wealth of detail. Drs. R. S. Becker and M. Kasha follow with a discussion of luminescence spectroscopy, involving the role of chlorophyll, and the electronic state of this pigment which is concerned with the first reaction in the utilization of energy by the pigment system. The luminescence properties of porphyrin molecules are being studied by these workers, with special reference to the chlorophylls, and the singlet-triplet split in molecules is considered.

Perhaps the most interesting and informative chapter, at any rate for porphyrin workers, is that of C. Stacy French on fluorescence spectrophotometry. He describes apparatus in detail, and follows up with a most useful account of the absorption and fluorescence spectra of the chlorophylls and their derivatives, data which are not readily accessible in the literature. Wilhelmsen *et al.* have a paper on chemiluminescence kinetics of the 2 : 3 dihydrophthalazine 1 : 4 diones, and a mechanism for the reaction is proposed, based on the ionization, in basic solution, of the enol forms shifting the equilibrium in their favour. Oxidation of the ionized portion would then involve loss of the charge, and reaction with more oxygen would lead eventually to a molecule which, when excreted, would emit light.

Two deeply interesting chapters are those dealing with the chemistry of *Cypridina* luciferin by Drs. Tsuji, Chase and Harvey, and the biochemistry of firefly luminescence by Drs. McElroy and Hastings. The first contains much detail regarding the preparation and purification of luciferin (chromatography and electrophoresis) and a study of degradation products. The second describes purification methods for luciferin and luciferase from *Photinus pyralis*, and gives some properties of the luminescent system, including the possible role of adenosine triphosphate. The biochemistry of bacterial luminescence is very fully discussed by Dr. Strehler, with some pointers as to the mechanism involved, which seems to include the participation of reduced flavin mononucleotide. Intracellular luminescence is introduced by Dr. Frank Johnson, the editor, and includes a study of the kinetics of bacterial luminescence *in vitro*.

From the biochemical mechanisms of luminescence, the reader moves to the physiological control of luminescence, the subject of Dr. Nicol's paper, which is further discussed and extended by Dr. Buck. Dr. Nicol's main concern is with neurocontrol; there are two effector systems, muscles and photocytes, which depend on one conductor system. Oxygenation may be a limiting factor. The survey of luminous organisms of the Far East, by Dr. Haneda, is a fascinating and most useful contribution; it contains several very fine photographs. The symposium ends with two short papers, one on marine dinoflagellates by Dr. Ryther, and one by Drs. Haxo and Sweeney on bioluminescence in *Gonyaulax polyedra*.

The sequence of the contributions could be criticized; for example, the papers on control of luminescence would have been more logically placed after the papers on firefly luminescence, and the very fine survey of Haneda after the introduction by Harvey. The paper is good, the print clear and the photographs have been reproduced well. There is a good index.

G. Y. Kennedy

Proceedings of the International Conference of Theoretical Physics, Kyoto and Tokyo, September 1953

Held under the auspices of The International Union of Pure and Applied Physics. Organized by The Science Council of Japan, with the collaboration of Kyoto University and The Physical Society of Japan. Supported by U.N.E.S.C.O. and The Rockefeller Foundation. Pp. xxviii+942. (Tokyo: Science Council of Japan, 1954.) n.p.

THE 1953 conference on theoretical physics in Japan was remarkable for a number of reasons: the wide range of topics treated by the eighty-four distinguished foreign visitors and the local participants; the fact that this was the first purely scientific international conference ever held in Japan; the hospitality bestowed on the fortunate guests; and the magnificence of this volume recording the proceedings. It all does full justice to the devotion accorded to theoretical physics in Japan, and the high achievement in the subject there.

The conference was concerned principally with the two broad domains of field theory and solid-state physics. In the former (Part 1 of the report), there was much deliberation on the various technical difficulties of non-local theory, intermediate and strong coupling theory, nuclear forces, etc. Part 2 is a shorter section on nuclear physics, mainly the shell model. The remaining, major portion of the volume comprises Part 3 on statistical mechanics, Part 4 on molecules and solids, and Part 5 on liquid helium and superconductivity.

Nearly as much space is devoted to discussions as to the actual papers, giving a picture of a lively and informal conference. Survey talks are an important feature, and altogether the book offers a valuable insight into the state of theoretical physics at the time, and the thoughts occupying the leading workers. However, this amounts largely to journalism, though on the grand scale, and already much water has flowed under the bridges of theoretical physics since the conference.

Yearbook of the United Nations, 1954

Pp. xii+656. (New York: United Nations; London: H.M. Stationery Office, 1955.) 10.50 dollars; 70*s*.

AS a reference work the value of this "Yearbook" appears to reside in the appendixes—which set forth the structure of the United Nations, the matters considered by the Principal Organs during 1954, the delegations to the General Assembly and the Councils, and the information centres and regional information centres—and in the documentary notes with which the several chapters are provided. These chapters themselves, however, although designed to facilitate the understanding of the work of the United Nations during the past year, appear to have rather a limited value except in official circles.

While the size and price of such an admirably printed and produced book restricts its general use, the chapters dealing with topics of interest to the scientist, such as the economic development of under-developed areas or the work of the United Nations Educational, Scientific and Cultural Organization or other specialized agencies, are not sufficiently detailed to preclude reference to the reports of various committees or other bodies. Something much more condensed might be of great value; even if there were discarded the material which gives a certain lack of realism to the treatment of questions regarding non-self-governing territories and the trusteeship system, some doubts may still be entertained as to the practicability of dealing readably in one volume with all the varied activities of the United Nations Organization.

Dictionary of Magic

By Harry E. Wedeck. (Midcentury Reference Library.) Pp. viii+105. (New York: Philosophical Library, 1956.) 3 dollars.

THIS little book is a convenient compilation of names, terms and expressions used in magic and occultism generally, although it would have been improved had the author made a rather better selection of his material and arranged it somewhat differently. The subject is so vast that all that could be expected in a book of this size is a very brief and condensed list, which, for the general reader, is likely to prove of some use since it is unlikely that he would have by him the larger works by such authors as Collin de Plancy, Spence, Verneuil or even the shorter glossary by Ernest Bosc.

Although the author has managed to include some entries not easily found elsewhere, he has done so at the expense of omitting more important items, and it is sometimes difficult to see on what basis the selection has been made. Moreover, persons are listed under their first names; and such entries as "Last witch", "New", or "Plato", who is said to have censured sorcerers that were hired to practise incantations, seem of doubtful utility. A little more care would have avoided these faults and also minor errors such as the spelling of "Bavan" for "Bavent" and the confusion between the two Moras, which is more excusable since this confusion was made both by Summers and, following him, by Prof. E. M. Butler in her valuable study of ritual magic.

E. J. DINGWALL

Variational Principles in Dynamics and Quantum Theory

By Dr. Wolfgang Yourgrau and Stanley Madelstam. Pp. ix+155. (London: Sir Isaac Pitman and Sons, Ltd., 1955.) 25*s*. net.

THE central importance of 'action' principles in modern theoretical physics fully justifies the authors in their attempt to provide a historical and critical exposition. Early chapters discuss the contributions of Fermat and Maupertuis; Dr. Akakia is not mentioned explicitly, but the authors appear to imply that König knew that the famous Leibniz letter was spurious—Is this quite certain? Then there is a technical section, dealing with the definitive work of Euler, Lagrange and Hamilton, and its applications to electrodynamics and quantum theory. Finally, a chapter on the philosophical aspects of action principles tries to maintain a balanced position, but inclines on the whole to the side of Planck rather than of Mach.

Thus two books have been cramped into a hundred and fifty pages, and on the whole it is the technical side which has suffered; for example, the extraordinary prescience of Hamilton's views is not adequately emphasized, and some technical ideas are brought in hurriedly and without due preparation, such as the relativistic interpretation of the modified Lagrangian function. Nevertheless, the mingling of historical and technical development is stimulating, and should assist the reader to a thorough realization of the immense value of the concept of action variation.

BRITISH ASSOCIATION MEETING IN SHEFFIELD

DURING August 29–September 5 this year, the British Association will hold its annual meeting in Sheffield. Sheffield has many advantages as a place of meeting for the British Association. One of the major centres of industry, exceedingly busy and dependent in almost every branch on the continuous application of scientific discovery, a visit provides a fine stimulus to any scientist; but, unlike most industrial centres, Sheffield is a surprisingly pleasant city, especially on its west and south sides, and it is set in surroundings of great natural beauty immediately accessible by bus or even on foot. Full advantage of these is being taken in the arrangements for the meeting. It is perhaps singularly appropriate that Sheffield should be chosen for the meeting this year, for a century ago, at the Cheltenham meeting in 1856, Bessemer made the first public announcement of his revolutionary steel-making process, for which shortly after he set up his own works in Sheffield.

The accommodation for the meeting will be divided between two centres. In the middle of the city, within easy reach of the railway stations and served by public transport from every district, will be the Reception Room (the Central Technical School—in the former Firth College). Within a few yards of this are the City Hall, where the large general meetings will be held, and the Cutlers' Hall, which will provide a convenient social centre. The section meetings will all be held in the University area, mostly in the University buildings. These are within easy walking distance of the Reception Centre; but, for the meeting, special buses for members will circulate between the Reception Centre and the section rooms, in addition to the regular public transport.

The inaugural meeting on the evening of Wednesday, August 29, will, as on a number of such occasions, be preceded by a short degree congregation, when the chancellor of the University, the Earl of Halifax, will confer honorary doctorates on Sir Raymond Priestley, president of the Association, and on Sir George Thomson and Sir Charles Goodeve, the presidents of Sections A and B, respectively. The president's address will be on "Twentieth Century Man against Antarctica", a subject most apposite and topical in view of the attention which is focused this year on the further exploration of the Antarctic by several important expeditions. Sir Raymond Priestley can speak with authority on this, because not only did he accompany both Shackleton and Scott to the Antarctic, but also he is still intimately associated with Antarctic exploration and development.

The two evening discourses will be on "The Growth of Biochemistry", by Prof. F. G. Young (August 31), and "The International Geophysical Year", by Prof. Sydney Chapman, chairman of the International Committee organizing the International Geophysical Year (September 3)—another subject of great topical interest.

It is, however, a prime object of the Association "to bring the objects of science more before the public eye". Many citizens who may be hesitant immediately to become members may yet wish to know more of what science means and to see at close quarters some of its leading figures. With them in mind, two further illustrated evening lectures have been arranged, freely open to the public, on "Antarctic Adventure", by Sir Raymond Priestley (August 30), and "The Future Development of Atomic Energy", by Sir John Cockcroft (September 4).

All these meetings will be held in the Main (Oval) Hall of the City Hall, which, seating 2,700, should accommodate the audiences in comfort.

But the heart of the gathering is in the meetings of the sections, and here will be encountered the richness and variety that have so long characterized the British Association. To summarize the very varied subjects that will be dealt with in presidential addresses and sectional communications would need a separate article. Here it may suffice to say that, while most aspects of scientific endeavour seem to be included, there will be, as is appropriate in a major centre of industry, a slight but appreciable emphasis on matters of industrial and technological importance, an emphasis reflected even in the proceedings of Section H, the general theme of which is to be "The Primitive Technology of Glass and Metals".

As in previous years, there will be an official service in Sheffield Cathedral on the Sunday morning, and other churches will hold special services. For the Sunday evening, the Local Committee has arranged for members a concert in the City Hall by the Hallé Orchestra and the Sheffield Philharmonic Choir, under Sir John Barbirolli and Mr. Herman Lindars.

A number of exhibitions have been arranged for the meeting, including one of polar rations, one of scientific glassware, and special displays at the City Museum and at the Graves Art Gallery, where there will also be a demonstration of the processes of picture restoration on an 'open evening'. It is hoped to arrange a display in honour of the Bessemer centenary, and, following the excellent lead given at Bristol, there will be an exhibition of "Science in Schools", organized by Mr. Stanley Moffett, director of education for Sheffield, and science masters and mistresses throughout the region. It is hoped to make this exhibition a fully 'live' show with most of the demonstrations and experiments actually working. A completely new departure will be a special exhibition of books *about* science arranged by the National Book League and staged in the Central Library. The professional scientist can generally find and assess the worth of technical books in his own field; but it is seldom that he can tell a lay friend where to find a book that explains the essentials in simple language—and outside his own field he is often quite lost. Here should be at least one answer to a difficult question, for which a great many members, scientists and laymen alike, may well be grateful. The regular showings of scientific films, begun in Bristol, will be continued in Sheffield in the convenient and well-equipped Library Theatre. Visitors to Sheffield will also be invited to inspect, in the same building, the Commercial and Technical Section of the Public Library, which provides a very

important service for industry, commerce and the student.

The problem of housing the large number of members expected has been carefully studied. In particular, the whole accommodation of the University halls of residence and of the training colleges throughout the area has been reserved. Several of these are very recently built and are fine examples of collegiate architecture. Some are in former great houses, such as Wentworth Woodhouse, magnificently situated and of great historic interest as well as substantial comfort. Special bus services, free to residents, will run at appropriate times between the more distant of these and the meeting centres. Members wishing to stay in hotels should make early bookings. Arrangements have also been completed for ample private accommodation for those preferring it.

The main catering centre will be the lower floor of the City Hall; here a large restaurant with both cafeteria and waitress service will enable members to take lunch and other meals close to the Reception Centre and to the main bus station for excursions. Light refreshments will be available also in the University Union, there will be coffee points near all section rooms, and a mobile canteen on the Association's bus station will supply packed meals on demand.

Some 140 general and sectional excursions have been planned, and a member who so wishes will have little difficulty in getting, within the week, a general idea of the heavy and light industries of the area and in appreciating the glorious countryside in which they are set. A special bus station, within easy reach of the University and Reception Centre, will be brought into use solely for the Association, and nearly every excursion will start and end there.

Under the title of "Sheffield and its Region", an extensively illustrated scientific survey of some 330 pages by twenty-seven contributors under the editorship of Prof. D. L. Linton will be presented to members attending the meeting. In three parts, the first gives an account of what may be termed the natural history, pre-history and history of the region; the second treats of "The City of Sheffield" and deals with aspects of its economic development, with the growth of its social institutions, with its contributions to art and science, and with its present characteristics and plans for the future. The third part, under the heading "The Region Today", deals with some of the industries by which the inhabitants of the region gain their livelihood and with the towns, outside Sheffield, in which they live.

The community of Sheffield looks forward eagerly to receiving its distinguished visitors, who are assured of a cordial welcome. This will be the third time that the Association has met in Sheffield. The first was in 1879, with Henry Clifton Sorby as one of the local secretaries, when Crookes demonstrated many of the properties of cathode rays. That year was an important one in Sheffield, for a few weeks after the members of the Association had dispersed, Prince Leopold, youngest son of Queen Victoria, opened Mark Firth's foundation, Firth College, from which the University has grown. The second occasion was in 1910. The depression in the Sheffield industries during the inter-war years probably accounts for the long interval between the second and the present meetings. The Local Committee now hopes that, in a city and region so devoted to the applications of science, there may be a large enrolment of local members, and trusts that the occasion may prove memorable both in Sheffield and to all those who visit it.

LEWIS EVANS (1700–56): A SCIENTIST IN COLONIAL AMERICA

By Prof. GEORGE W. WHITE
Department of Geology, University of Illinois

LEWIS EVANS, who died two hundred years ago on June 11, earned his living as a professional engineer and cartographer; he was a geographer and natural scientist as well. He was born in 1700 at Llangwnadl, near Pwlhelli, Carnarvonshire, Wales[1]. It is not known how and when he came to Colonial America; but in 1736 he was a surveyor and mapmaker in Philadelphia. He had associations with Benjamin Franklin, purchased books from him, and probably did some drafting and engraving for him. He travelled extensively with John Bartram, Botanist to the King; gave much information to Peter Kalm, the Swedish scientific traveller; and provided geographical and other service to Governor Thomas Pownall. These men and others of the time quote Evans's scientific opinions in their writings approvingly and at some length.

Evans made valuable observations on plants, animals, and meteorology, and in other fields of science. His knowledge of astronomy and physics ('natural philosophy'), including electricity, was such that he gave series of lectures on these subjects in 1751 in Philadelphia, Newark and New York. Thirteen lectures made up the series in New York. His maps of the middle Atlantic Colonies went through more than twenty editions, although most of them were printed without credit to Evans. His topographical descriptions formed the physiographical groundwork for American geographical description (again usually without credit) for more than fifty years. His most important scientific contributions were his penetrating geological observations about eastern North America and the respectable theories, some of them far in advance of his time, that he based on them[2].

Evans travelled extensively through the middle Atlantic Colonies across the Coastal Plain, Piedmont, the folded Appalachian Mountains, and made at least one journey across the Appalachian Plateau to Lake Ontario. These observations were the basis of his maps of 1749 and 1752[3] of Pennsylvania and of his famous map of the Middle Atlantic Colonies of 1755[4]. In his journal[5] of a trip in 1743 to Lake Ontario (published by Governor Thomas Pownall in 1776),

Evans noted the fossils in the Palæozoic rocks and understood their marine origin. He recognized that the present Appalachian ridges with their even skyline were erosional remnants and that the sediment derived from the erosion now forms the Coastal Plain. He says[6] the mountains " . . . were formerly but one large Plain, inclining with a considerable Slant towards the Sea; that this has been worn into its present Appearance of Ridges, with Vales between them, by the Rains of the Heavens and Waters of the Earth washing away the Soil from the upper Parts, and carrying it down to Seawards. That the Soil thus carried down and lodged in various Places hath in a Series of Ages formed the lower Plains of the Jerseys, Pennsylvania, Maryland, Virginia, and the Carolinas".

Near Lake Ontario Evans saw the raised beaches of the Pleistocene Great Lakes and correctly interpreted them as marking once higher water-levels. He further recorded at some length in his journal his opinion that the lakes had been partly drained, causing what is now called 'isostatic rebound'[7]: "This Part of America, disburthened of such a Load of Waters, would of course rise, as the immediate Effect of the shifting of the Center of Gravity in the Globe at once or by Degrees, much or little".

In his maps of 1749 and 1752 Evans recorded geological notes and filled in one extensive blank part with a lengthy description of the "Endless [Appalachian] Mountains". In his map of 1755 he could find no space for geological notes and published them separately in a booklet of 36 pages, "An Analysis of a General Map of the Middle British Colonies . . .", in which he gave a clear statement of the physiographical and geological provinces of what is now the eastern part of the United States, including New England. His classification (but not his terminology) of the separate physiographical provinces is that still in use. He expressed his regret that the map had no room for sections in several directions to show not only the hills and valleys on the upper surface, but also[8]: " . . . on the lower, the Nature of the Soil, Substrata and particular Fossils may be exprest. It was with Regret I was obliged to omit it. But in some future Maps of Separate Colonies, I hope to be furnished with more Room".

Evans had a keen realization of geopolitical realities—too insistently expressed for his own personal good and for his scientific future. He knew the richness of the country west of the mountains and the necessity of firmly attaching this heartland to the eastern provinces. This country he called the "Ohio country" and said is "The Flower of the whole Globe" and "the finest Country on Earth"[9]. He expressed most emphatically and pungently his opinion that the Colonial authorities were misguided, careless, stupid, and possibly even treasonable in allowing the French to penetrate from Canada into the territory west of the mountains and south of the Great Lakes—the territory now known as the "Middle West". Evans was sure any intelligent Briton could see that this land must be reserved for English settlement. This forthright, correct, but somewhat intemperate criticism of authority was poorly received; charges were preferred and he was jailed in New York in the spring of 1756. Evans, suffering from a "lingering indisposition", was released on June 8, on "his Majesty's Writt of Habeus Corpus", but died three days later on June 11.

It is tempting to speculate that had Evans lived a few more years, and devoted himself to cartography and science, maps of separate colonies would have been produced accompanied by geological sections and probably by further geological descriptions. He might have taken additional part in the developing studies of electricity and possibly in other phases of natural science. What he had already done ensures him a place in the history of science in Colonial America.

[1] Biographical information will be found in Stevens, H. N., "Lewis Evans, his Map of the Middle British Colonies . . ." (H. Stevens, Son and Stiles, London, 1905, 1920, 1924). Wroth, L. C., "An American Bookshelf 1755" (University of Pennsylvania Press, 1934). Gipson, L. H., "Lewis Evans" (Historical Society of Philadelphia, 1939).

[2] White, G. W., "Lewis Evans' Contributions to Early American Geology, 1743–1755", *Trans. Ill. Acad. Sci.*, **44**, 152 (1951).

[3] Evans, Lewis, "A Map of Pennsylvania, New Jersey, New York . . ." (Philadelphia, 1749, 1752).

[4] Evans, Lewis, "A General Map of the Middle British Colonies . . ." (B. Franklin and D. Hall, Philadelphia, 1755).

[5] Pownall, Thomas, "A Topographical Description of Such Parts of North America as are Contained in the (Annexed) Map of the Middle British Colonies in North America" (J. Almon, London, 1776).

[6] *Ibid.*, p. 29.

[7] White, G. W., "Lewis Evans' Early American Notice of Isostasy", *Science*, **114**, 302 (1951).

[8] Evans, Lewis, "An Analysis of a General Map of the Middle British Colonies . . ." (B. Franklin and D. Hall, Philadelphia, 1755); also facsimile reprint in Gipson, *op. cit.*, p. iv.

[9] *Ibid.*, pp. 28–38.

THE IVEAGH GEOLOGICAL LABORATORY, TRINITY COLLEGE, DUBLIN

By Prof. W. D. GILL

THE reconstructed Iveagh Geological Laboratory at Trinity College, Dublin, was formally reopened on May 10 by the Chancellor of the University of Dublin, the Right Hon. the Earl of Iveagh, K.G., before a company of Fellows and staff of the College, and guests including many distinguished geologists from universities, the Civil Service and industry in Ireland and Britain. Before the reopening ceremony, the Chancellor had conferred the degree of Sc.D. (*honoris causa*) on Sir Harold Jeffreys (Cambridge), Prof. P. H. Kuenen (Gröningen) and Prof. H. H. Read (London).

The Chancellor recalled the deep impression made on him as a young man by Prof. John Joly. It was through his father's friendship with Joly, and his admiration for his work, that the association of the School of Geology and the Iveagh family had sprung. The abiding record of this friendship is an endowment of £10,000 to assist the work of this School.

The Iveagh Geological Laboratory is housed in the Museum Building, built under the influence of the principles of Ruskin between 1853 and 1857 to accommodate the Schools of Engineering and Geology. The building is certainly important and interesting, though perhaps controversial from the architectural and æsthetic points of view. The great columns of Irish marbles, including particularly fine samples of serpentine marble from Connemara, which support the arches of the Byzantine interior, are very impressive. Both engineering and geology were provided with very large museums, occupying the full 90 ft. of the width of the building at either end. These rooms covered 3,150 sq. ft. of floor space and were some 30 ft. high. The provision of teaching and research facilities was, however, on a greatly disproportionate scale, and could not be much improved. The main reconstruction has been the building of an upper floor in the old Geology Museum. A museum of type, figured, and reference collections now occupies 1,250 sq. ft. of the upper floor, the remainder being taken up by a mapping and photogrammetrical laboratory, a library and a research laboratory. Various oil companies and their associates have contributed generously towards the provision of photogrammetrical equipment, which is used both by geologists and geographers, and their generosity is recorded on a plaque on the wall of the photogrammetrical laboratory.

The floor of the former museum contains the main teaching laboratories and staff rooms. The three laboratories (elementary 956 sq. ft., palæontology 660 sq. ft., and petrology 550 sq. ft.) are dual-purpose rooms, permitting the fullest integration of lectures with practical demonstrations.

From the old accommodation at the level of the main hall of the building is retained a block of rooms, including the photographic room, preparation room and a laboratory for the research unit engaged under the direction of Mr. G. F. Mitchell, in Quaternary studies.

To offset the loss of display space in the new museum, the entrance hall has been furnished with wall cases, which display selections from the fine mineral and fossil collections, together with 'teaching gallery' exhibits intended to present various aspects of geology to the students of many departments who come to lectures in other parts of the building. On either side of the entrance hall stand skeletons of *Cervus giganteus*, perhaps the most famous of Irish fossil animals.

To the staff of the School of Geology has fallen the onerous task of removing, storing and replacing the museum collections. It was rewarding, however, to discover during this work the history of the School, and to see the stamp of those who made it. It is clear that the chair of geology was created in conjunction with the establishment of the School of Engineering in 1841; John Phillips was the first professor, followed after two years by Thomas Oldham. Although Oldham's main career lay in India, he forged a link between Irish and Indian geology which was to last until the end of the century. Ball, Meddlicott and Wynne are names common to the books of Trinity College and to the pioneering surveys of the Geological Survey of India. Meddlicott was prizeman in chemistry and geology in 1850. Oldham sent many specimens of minerals, rocks and fossils (including the Siwalik mammals) from India to enrich the collections. Oldham was followed by Samuel Haughton, whose interests and achievements ranged from the emplacement of granite to the fossil mammals of post-glacial times, and who finally became a distinguished medical scientist. Until 1881, the chair of mineralogy had a separate tenure. The first holder, James Apjohn, was also University professor of chemistry. The superlative quality of the mineral collections undoubtedly reflects the industry of collectors early in this field. To Prof. W. J. Sollas, who held the chair of geology for fourteen years before he went to Oxford, is owed the acquisition of the Huxley types of the Jarrow amphibia, and a great variety of type and figured specimens of his era. Most of the systematic collections of Irish rocks were started by him. John Joly's many-sided genius probably gave the School of Geology its highest and widest known reputation. Like many of its most distinguished sons, Joly came to the science of geology from the School of Engineering—and this, in the old days, meant through mineralogy. Joly remained throughout his life a keen collector of minerals, and his large collection, recently presented by Mrs. Henry Dixon, is particularly rich in metamorphic minerals.

The work of the late Prof. L. B. Smyth on the Carboniferous rocks and fossils of Ireland deserves wider recognition than it has received either in Trinity College or elsewhere. This unassuming man left a complete record of his meticulous comparative and descriptive work, which forms an invaluable foundation on which to build a study of the stratigraphy of the Carboniferous rocks covering two-thirds of the country. The fossils upon which the teaching of invertebrate palæontology is based also bear the stamp of a palæontologist of rare ability.

With this rich harvest from the labours of so many distinguished forbears, and the provision of up-to-date teaching and research facilities, the School of Geology in Trinity should be able to maintain the high reputation earned by its graduates over the past century. The main difficulty in expanding research activity is the poor provision in Ireland for postgraduate students compared with that in Britain. There is hope, however, that this situation will be remedied in the near future. In spite of these difficulties, the School of Geology has had two full-time research students in the past two years.

As many departments of geology in British universities have found in the past decade, there is much untouched research ground in Ireland, presenting a wide range of problems to be solved. The basic mapping of the country was done between 1860 and 1880, at a time when only the bare outlines of the science were established. It is not surprising, therefore, that field geology is so frequently rewarded by the discovery of undocumented phenomena. In the past, Ireland's own contribution to the rediscovery of Irish geology has had to rely on a few outstanding individuals. It is hoped that the new provision made by Trinity College will help to expand the scope, and increase the production of geological research.

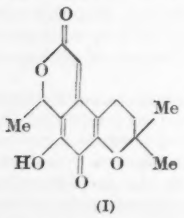
In field-mapping, petrographic and palæontological studies of Carboniferous rocks; in tectonics and the study of cleavage developed in fold systems; in field relationships and petrological studies of volcanics; in Quaternary studies, including the field-mapping and laboratory studies of drift deposits; in palæobotany and micropalæontology, there is ample scope for research workers, who will receive willing assistance from the University and from the Geological Survey of Ireland.

ANTIBIOTICS AND MOULD METABOLITES

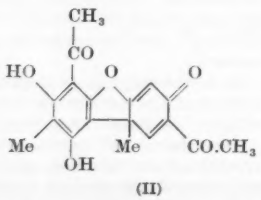
THE anniversary meeting of the Chemical Society was held this year in Nottingham, on March 26, and included a symposium on "Antibiotics and Mould Metabolites", organized by Prof. A. W. Johnson. Four papers were read during the morning: "Fungal Quinones", by J. H. Birkinshaw (London School of Hygiene and Tropical Medicine); "Synthesis of some Fungal Metabolites", by D. H. R. Barton (University of Glasgow); "Azaphilones, a General Survey", by A. D. G. Powell, Alexander Robertson and W. B. Whalley (University of Liverpool) and "The Structure of Purpurogenone", by J. C. Roberts (University of Nottingham).

Dr. Birkinshaw reviewed the chemistry of the fungal quinones and paid particular attention to the structural regularities which have enabled theories of biogenesis and metabolism to be developed. Examples of simple benzoquinones were quoted as well as dibenzoquinones, 2 : 5-diphenylbenzoquinones and the naphthaquinones, including actinorhodin which is possibly a dinaphthaquinone. The hydroxy-anthraquinones form the largest group of the fungal quinones, and these were sub-divided into those containing only α-hydroxy groups and those containing β- as well as α-hydroxy groups. The latter formed two main types, those based on emodin and those based on catenarin. Other hydroxy-anthraquinones which were not included in the above groups were also discussed. Examples of dianthraquinones and related compounds were cited, as well as the case of thelephoric acid, a phenanthraquinone. Citrinin, fuscin and purpurogenone form a separate class of hemiquinones or quinomethines, and the final examples mentioned included quinols and quinhydrones, the existence of which supports the idea that the quinones are concerned in the respiratory processes of the particular organisms. In the ensuing discussion, Prof. A. J. Birch (Manchester) stressed the importance of the acetate hypothesis in deciding the position of quinone substituents and in correlating the structures of the fungal quinones in general.

Prof. Barton then read his paper on the recent syntheses in his own laboratory of two fungal metabolites, fuscin and usnic acid. Fuscin was isolated by Michael in 1948, and its reactions and degradations were studied in detail by Birkinshaw, Bracken, Michael and Raistrick. Prof. Barton then deduced structure (I), which had been reported independently by Birch, for fuscin; he provided plausible explanations of its various reactions and described the total synthesis of the compound.

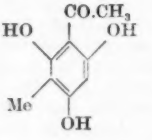


(I)



(II)

In a second section, Prof. Barton discussed the chemistry of usnic acid (II), which can be dissected into two biogenetic units of methylphloracetophenone (III). Once it had been realized that the dimer of *p*-cresol formed by ferricyanide oxidation should be formulated as (IV), a similar oxidation with methyl phloracetophenone was found to give the expected dimer which yielded racemic usnic acid on dehydration.



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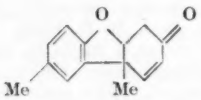


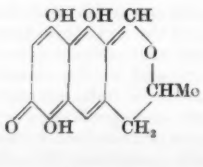
(IV)

In the discussion Prof. Barton said that the dimer of *p*-cresol had also been obtained by oxidation with peroxidase by earlier workers; but even so it had not been obtained in an optically active form, probably because the reaction had not been carried out under proper physiological conditions.

In the third paper, by Powell, Robertson and Whalley, Dr. Whalley gave a general survey of the complex chemistry of the azaphilones, a group of five pigments: sclerotiorine, $C_{21}H_{23}O_6Cl$, from *P. sclerotiorium* van Beyma; a new pigment, rotiorine, $C_{22}H_{22}O_5$ (or $C_{23}H_{24}O_5$), from the same organism; monascin, $C_{21}H_{26}O_5$, and monascorubrin, $C_{22}H_{24}O_5$, both isolated from *M. purpureus* Wentii; and a new metabolite, rubropunctatin, $C_{22}H_{24}O_5$, from *M. rubriginosus* Sato. These metabolites constitute a family of substances of hitherto unknown type, which, with the exception of monascin, give rise with exceptional facility to reaction products with ammonia. Hence these metabolites, which have many structural features in common (*inter alia*, the presence of a lactone grouping and one or more alkyl side-chains, the absence of hydroxyl groups and aromatic nuclei, and the ready conversion of the 'ammonia compounds' to *iso*quinolines), are designated by the generic term azaphilones.

The extensive analytical work concerning the structure of sclerotiorine has made it possible to assign a tentative structure to this pigment.

In the final paper of the morning session, Dr. Roberts discussed the isolation and structure (V) of the mould pigment purpurogenone, $C_{14}H_{12}O_5$, isolated from *P. purpurogenum* Stoll. Details were given of the various reactions of purpurogenone, including the conversion by alkali to a derivative of naphthapurpurin and the chromic acid oxidation of purpurogenone triacetate to 3-hydroxybenzene-1 : 2 : 5-tricarboxylic acid.



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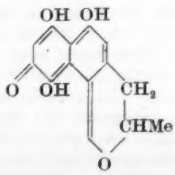
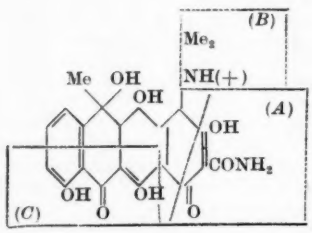


(VI)

A possible biogenetic route based on the acetate hypothesis was supported. A lively discussion of various features of this novel structure occurred, and suggestions were made for distinguishing (V) from the alternative, though less likely, angular structure (VI).

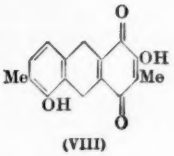
In the afternoon three papers were read: "Progress in the Chemistry of Oxytetracycline and Related Compounds" by L. H. Conover (Chas. Pfizer and Co., Inc., New York); "Actinomycin", by A. W. Johnson (University of Nottingham) and "Chemistry of the Cephalosporins", by E. P. Abraham and G. G. F. Newton (University of Oxford), read by the latter.

Dr. Conover began his talk by reminding his audience of the structural relationship between terramycin (VII) and aureomycin, both derivatives of tetracycline and now officially named oxytetracycline and chlorotetracycline respectively. He then summarized briefly the degradative experiments which enabled these structures to be deduced. The main part of Dr. Conover's talk was devoted to recent work on oxytetracycline and comprised (i) the interpretation of certain aspects of the spectra and the acidities of simpler structures related to the antibiotics; (ii) the use of model compounds in elucidating the primary site of metal complexing of the antibiotics; (iii) the identification of the specific centres responsible for the three titratable acidic dissociations of the antibiotics; and (iv) some new reactions of oxytetracycline and its analogues. In the first section, evidence was presented for steric inhibition of resonance being an important factor as well as variations in the strength of hydrogen bonding in controlling the physical properties of *o*-hydroxy- and *o*-alkoxyaromatic carbonyl compounds. In the second and third sections, it was established that the site of the metal complexing is the 2-acyl-8-hydroxytetralone fragment of the molecule, and that the three acidic groups of pK_a 3·3, 7·3 and 9·1 in oxytetracycline can be attributed to the tricarbonylmethane system (VII; *A*), the ammonium cation (VII; *B*) and the phenolic β-diketone system (VII; *C*), respectively.

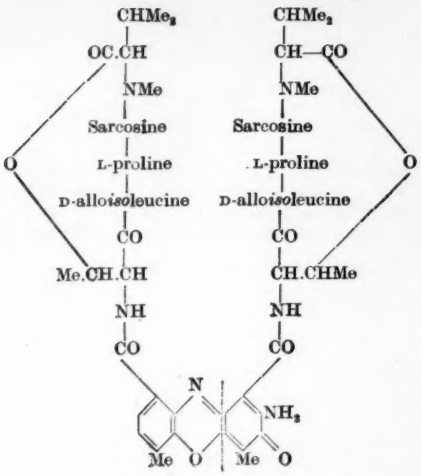


(VII)

In his final section Dr. Conover put forward theoretical mechanisms for the unexpected formation of tetramethylammonium iodide from the action of methyl iodide on oxytetracycline and postulated that the observed epimerization of the tetracycline antibiotics in acidic solution involves equilibration at C_4.



(VIII)

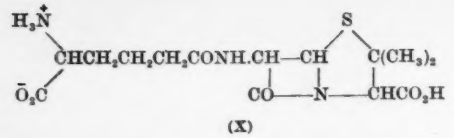


Actinomycin C_3 $C_{44}H_{60}O_{16}N_{12}$ (Brockmann)

(IX)

Prof. Johnson outlined the isolation, nomenclature and early work on the structure of the actinomycin group of antibiotics which have been claimed to have a certain degree of cytostatic activity. The difference between the various members of the groups lies in the composition of the peptide chain and, so far as is known, the chromophore is common to all. Until recently the only degradation product from actinomycin was the compound despeptidoactinomycin or actinomycinol, produced by the action of baryta. The structure of this compound (VIII) was announced in papers submitted from both Göttingen (Brockmann *et al.*) and Cambridge on the same day. Quite recently, Brockmann has been able to advance a complete structure (IX) for actinomycin by a careful study of the graded acid hydrolysis. This structure is remarkable because of its relation to xanthommatin, an insect pigment recently isolated and identified by Butenandt, and also because it can be synthesized *in vitro* as well as *in vivo* by the oxidative coupling of two molecules of the 6-hydroxy-5-methylanthranilic acid peptide. Variations in the peptide chain and unsymmetrical coupling can give rise to the various actinomycins.

In the final paper, Dr. Newton said that a *Cephalosporium* sp. (obtained from Prof. Brotzu) produces two groups of antibiotics. One group, cephalosporin P, contains five related antibiotics that can be extracted into solvents. The other group contains two hydrophilic substances—cephalosporin N and cephalosporin C. Cephalosporin P_1 ($C_{32}H_{48}O_8$), the major component of the cephalosporin P family, contains an αβ-unsaturated carboxyl, two hydroxyl and two acetoxy groups. The $C_{27}H_{39}$ residue is tetracyclic. Cephalosporin P_1 is related to helvolic acid ($C_{33}H_{46}O_8$). Cephalosporin N is a new type of penicillin having a residue of D-α-aminoadipic acid in the side-chain. Its physical and antibacterial properties differ strikingly from the penicillins previously encountered. Degradation studies have shown that cephalosporin N is very probably (*D*-4-amino-4-carboxy-*n*-butyl)penicillin (X).



(X)

Cephalosporin C ($C_{16}H_{21}O_8N_3S$) behaves like a penicillin in some respects but not in others. Like cephalosporin N, it contains a residue of D-α-aminoadipic acid in the side-chain and has an absorption band in its infra-red spectrum characteristic of a penicillin. Unlike cephalosporin N, it shows an absorption band ($\varepsilon_{max.}$ 9,000) at 260 mμ, is not inactivated by penicillinase and gives no penicillamine on hydrolysis with hot acid. However, DL-valine has been isolated from the hydrolysate of cephalosporin C treated with Raney nickel.

The papers of the symposium, with bibliographies, will be published by the Chemical Society as "Special Publication No. 5", which will include also an account of the discussions following each paper.

A. W. Johnson

OBITUARIES

Dr. Stanley Whitehead

By the death of Stanley Whitehead on May 5 at the early age of fifty-three, electrical engineering has lost one of its far-sighted leaders in the research field and the Electrical Research Association a director who has considerably widened its scope and activities. He entered Oxford with an open scholarship, where he took firsts in the Final School in Physics and Mathematical Moderations. In 1925 Whitehead accepted the post of physicist in the Electrical Research Association and proceeded to a part-time study of electrical engineering at East London (Queen Mary) College, which led in 1930 to a Ph.D. and in 1952 to a D.Sc. degree of the University of London.

His early work with the Electrical Research Association led to the production of three critical surveys of dielectric phenomena covering breakdown phenomena in solid, liquid and gaseous dielectrics. This interest in dielectrics was maintained throughout his career and culminated in the monograph "Dielectric Breakdown of Solids" (Clarendon Press, Oxford, 1951), in which dielectric failure in all its aspects, for example, electronic breakdown, breakdown through thermal effects and by discharges in gaseous voids, was surveyed. His own theoretical researches on thermal breakdown and his experimental researches with colleagues on void discharges have proved useful contributions to knowledge. Problems of electrotechnical interest to which he has made contributions include those concerned with electrical transmission, cable ratings, and telephone and radio interference. During the Second World War he took a leading part, often at considerable personal risk, in the work of the Electrical Research Association on mine and bomb location.

Whitehead shouldered many responsibilities. He was chairman of the Science Abstracts Committee of the Institution of Electrical Engineers and a past chairman of the Measurements Section, honorary treasurer of the Institute of Physics, and a past vice-president and chairman of the London Branch, a past joint-secretary of the Parliamentary and Scientific Committee, and the chairman of the Committee of Directors of Research Associations. He was the chairman of the governors of his old school, Sir Walter St. Johns, of Battersea, and a governor of Battersea Grammar School. But his interest in education did not stop there; many young graduates about to embark on a career in research received guidance, and often he was instrumental in securing for them financial support. One of the rewards accorded him in 1952 which gave him great pleasure was his fellowship of Queen Mary College.

Stanley Whitehead married in 1929 Mary Lyon Morehead; they had met at Oxford, where she too had a distinguished academic career, but on the classical side. There are two children of the marriage, a boy and a girl.

R. Davis

Dr. T. Richards

Taliesin Richards, senior lecturer in the Department of Microbiology, University of Reading, died on January 13 at the early age of forty-two, having been born on November 26, 1913; his loss to the Department is great. Richards read chemistry at King's College, University of London, and obtained a B.Sc. with first-class honours in July 1936. He then entered the London School of Hygiene and Tropical Medicine to read for the postgraduate diploma in bacteriology, which he obtained in July 1937. Thus he entered the field of microbiology by postgraduate study, building upon a foundation of general chemistry a knowledge of microbial physiology and microbial forms and the techniques for studying them. He continued at the London School of Hygiene, doing research in the department of Prof. H. Raistrick, for which he obtained a Ph.D. in 1939.

In September 1939 Richards was appointed independent lecturer in charge of the, then, Agricultural Bacteriology Laboratory in the Faculty of Agriculture, University of Reading, where students reading for the degree of B.Sc. in dairying received instruction in microbiology. Richards and his colleagues were also responsible for the course for the postgraduate diploma in general bacteriology (now discontinued). These courses owed much to Richards, who moulded them during the difficult war period and after. The experience gained in the design and teaching of these courses was of much value when later (March 1951) the laboratory was absorbed into a new Department of Microbiology in the Faculties of Science and of Agriculture. Richards was appointed senior lecturer in the new Department and continued to be particularly concerned with the courses for the B.Sc. (Dairying) degree. In planning the courses for the new degree subject of microbiology in the Faculty of Science, Richards's knowledge and experience were drawn upon to great advantage, and he himself did a considerable amount of teaching in these new courses. Richards was a good teacher and took much

patient interest in the problems of students both in and out of the laboratory. He was much interested in student life in the University generally, and delighted in following the careers of his former students.

Richards's scientific interests covered a wide field in bacteriology. His papers included studies on the heat disinfection of *Streptococcus faecalis*, the development of media for the detection and enumeration of lipolytic micro-organisms, and the development of chemically defined media for classification in the *coli-aerogenes* group. He was an excellent microscopist and photographer. In spite of the difficult situation in the laboratories during the War and the later changes consequent on re-organization and development, Richards always managed to keep some personal research interests going, and to supervise a succession of research students.

Richards was an active member of the Society for Applied Bacteriology; he was elected to the committee in 1943, became an assistant editor of the *Proceedings* of the Society in 1945 and was its editor during 1948–50, until compelled by ill-health to resign. By then he had been able to carry out much work preparatory to the appearance of the *Journal of Applied Bacteriology*, and he continued until his death to give valuable assistance to his editorial successors. Richards was an active member of the Association of University Teachers and was for two years a Central Council representative of the University of Reading branch. He leaves a widow and two sons.

B. C. J. G. KNIGHT

NEWS and VIEWS

The Queen's Birthday Honours

THE following names of scientists and others associated with scientific work appear in the Queen's Birthday Honours list:

Viscount: Lord Cherwell, lately Dr. Lee's professor of experimental philosophy in the University of Oxford, for public services.

Barons: Sir Henry Cohen, professor of medicine in the University of Liverpool, for services to medicine; Sir Ronald Weeks, chairman of the National Advisory Council for Education in Industry and Commerce, and president of the British Scientific Instrument Research Association.

O.M.: Lord Hailey.

K.C.B.: Sir Gordon Radley, director-general of the General Post Office.

K.B.E.: Lord Glentanar, member of the Scottish Agricultural Advisory Council; Edmund G. Harwood, deputy secretary, Ministry of Agriculture, Fisheries and Food; Hugh N. Hume, deputy chairman, Colonial Development Corporation, and for other public services; Sir Thomas Merton, treasurer of the Royal Society.

Knights: Prof. Samuel P. Bedson, emeritus professor of bacteriology, University of London; Prof. Harry G. Champion, professor of forestry, University of Oxford; Prof. William J. Pugh, director of the Geological Survey of Great Britain and the Museum of Practical Geology (Department of Scientific and Industrial Research); Allan S. Quartermaine, president during 1951–52 of the Institution of Civil Engineers; John F. Wolfenden, vice-chancellor of the University of Reading.

C.B.: J. Anderson, chief scientist, Admiralty Signal and Radar Establishment, Portsdown, Cosham, Hants; H. S. Gilham, assistant comptroller, Patent Office (Board of Trade); J. I. Magowan, lately permanent secretary, Ministry of Agriculture, Northern Ireland.

C.M.G.: D. H. Black, chief scientific officer, Ministry of Supply; Dr. C. E. Lucas, director of marine and freshwater fishery research, Scottish Home Department.

C.B.E.: C. B. Bisset, director of the Geological Survey, Tanganyika; L. Boddington, deputy chief scientific officer, Ministry of Supply; Dr. F. P. Bowden, reader in physical chemistry, University of Cambridge; R. M. Currie, head of the Work Study Department, Imperial Chemical Industries, Ltd.; J. R. V. Dolphin, chief engineer, Atomic Weapons Research Establishment, United Kingdom Atomic Energy Authority; A. S. Fortune, chief inspector, Department of Agriculture for Scotland; E. T. Green, for services to agriculture in Northern Ireland; Dr. P. D'Arcy Hart, director of the Tuberculosis Research Unit, Medical Research Council; G. V. B. Herford, deputy chief scientific officer, Pest Infestation Laboratory (Department of Scientific and Industrial Research); A. B. Mann, chief mechanical and electrical engineer, Ministry of Works; Prof. K. Mather, professor of genetics, University of Birmingham; J. E. Peat, deputy senior officer, Empire Cotton Growing Corporation, Tanganyika; J. D. Peattie, chief engineer, Central Electricity Authority; S. P. Peters, deputy director (forecasting), Meteorological Office (Air Ministry); G. Williamson, principal of the Veterinary School, Federation of Nigeria; F. N. Woodward, director of the Institute of Seaweed Research.

I.S.O.: J. F. Sinclair, principal, Ministry of Agriculture, Fisheries and Food; R. I. Wells, principal scientific officer, Air Ministry.

Directorship of the Science Museum, London: Dr. T. C. S. Morrison-Scott

DR. T. C. S. MORRISON-SCOTT, a principal scientific officer in the British Museum (Natural History), has been appointed director of the Science Museum, London, in succession to the late Dr. F. Sherwood Taylor. Dr. Morrison-Scott was born in 1908; he went to Christchurch, Oxford, where he read history and law, and later to the Imperial College of Science and Technology, where he graduated with first-class honours in zoology in 1935. After a period as a biology master at Eton, he became a research student at the Zoological Society of London, and joined the British Museum (Natural History) in 1936. During the Second World War, he served with the R.N.V.R., and was awarded the Distinguished Service Cross. During the earlier part of his career Dr. Morrison-Scott was mainly interested in ecology in relation to evolution. At the British Museum he was assigned to the Mammal Section of the Zoological Department, under M. A. C. Hinton, and ultimately he assumed charge of that section. After the War he also became the officer in charge of the Tring Museum. His research work has covered a wide range of mammalian topics from

historical investigations into such matters as the identity of the kangaroo discovered by Captain Cook's expedition in 1770 and of the cats of ancient Egypt, to morphological investigations into the growth and succession of elephants' teeth. His major contributions have, however, been in the field of taxonomy; publications such as the Check List of Palæarctic Mammals (jointly with J. R. Ellerman, 1951) and Southern African Mammals (with J. R. Ellerman and R. W. Hayman, 1953) won immediate recognition and have become standard works of reference. In addition to his work in the Museum he has played a prominent part in other zoological affairs. He has been honorary treasurer since 1950 of the Zoological Society of London. At the thirteenth and fourteenth International Congresses of Zoology he was much involved in the activities of the Section on Zoological Nomenclature, and he is the honorary treasurer of the forthcoming fifteenth Congress in London in 1958. Among his hobbies are sailing and skiing; he is an amateur astronomer and is no mean lathe-turner.

Prehistoric European Archæology in London: Prof. J. D. Evans

Mr. J. D. Evans, whose appointment to the chair of prehistoric European archæology tenable at the University of London Institute of Archæology has recently been announced, is an outstanding product of the Department of Archæology and Anthropology at Cambridge. After taking his Tripos, in which he gained a first class with distinction, Mr. Evans entered on a course of research on the prehistoric archæology of the Mediterranean with special reference to relations between the eastern and western basins. He began by studying the Neolithic and Early Metal Age cultures of Spain, working under Santa-Ollala at Madrid and under Pericot y Garcia at Barcelona. Next he held a fellowship at the British Institute of Archæology at Ankara, during the tenure of which he took part in excavations, not only in Turkey, but as far afield as Jericho. At this stage his original plan was interrupted by an invitation from the Royal University of Malta to prepare a survey of the known monuments and archæological material from the Maltese Islands. In his paper on "The Prehistoric Culture-Sequence in the Maltese Archipelago", published in the *Proceedings of the Prehistoric Society* (19, 41; 1954), Evans made known the results of his analysis of the pottery, and he has since, in a communication to the Society of Antiquaries, of which he was elected a Fellow in 1955, published the results of his own excavations, by means of which he has been able to confirm his sequence and to relate to it the main prehistoric structures of the islands. Mr. Evans, who has held a research fellowship at Pembroke College, Cambridge, since 1953, has thus gained that broad experience of European prehistory that one has a right to expect of the successor to Prof. V. Gordon Childe.

Physics at Exeter: Dr. G. K. T. Conn

Dr. G. K. T. Conn, at present reader in physics in the University of Sheffield, has been appointed professor of physics in the University of Exeter in succession to Prof. H. O. W. Richardson, who is taking up the chair of physics at Bedford College, London. Dr. Conn graduated in mathematics and natural philosophy from the University of Aberdeen in 1933, and then spent the following five years in the Cavendish Laboratory, Cambridge, working on research problems in infra-red spectroscopy, a field which has since engaged a major part of his activities. In 1938 he was appointed to an assistant lectureship at the University of Sheffield, and it is there that he has developed his research to an impressive extent. His contributions on the optical properties of metals have made him a recognized authority in this field and have led to a substantial number of papers on new techniques covering a wide range. Recently he has extended this work to semi-conductors, and the broad field of his activities may be described as the physics of the solid state. His publications include contributions on vacuum gauges and low-pressure measurements as well as the study of the magnetic properties of solids in connexion with investigations in other fields. Dr. Conn possesses an original and inventive mind, with an unusually wide range of knowledge and general interests. His freshness of outlook at all levels of teaching and his active participation in many student activities have combined to make him an invaluable member of the physics staff at Sheffield.

Paris Academy of Sciences: Elections

Prof. M. Fréchet, formerly professor of mathematics in the University of Paris, has been elected a member of the Geometry Section of the Paris Academy of Sciences in succession to the late Prof. E. Borel. The following have been elected *correspondants* for the Geometry Section: Prof. H. Milloux, professor of differential and integral calculus in the University of Bordeaux, in succession to the late Prof. H. Dulac; Prof. C. L. Siegel, formerly professor of mathematics in the University of Frankfurt am Main, in succession to the late Prof. H. Weyl; and Prof. Marston Morse, of the Institute for Advanced Study, Princeton, in succession to the late Prof. F. Riesz.

University of Leeds: Building Developments

A gift of £21,000 has been made by Brotherton and Co., Ltd., to the University of Leeds towards the building fund for the Chemical Engineering Section of the Department of Coal Gas and Fuel Industries. This firm has for many years given substantial financial help to the University for the purpose of furthering teaching and research in the Departments of Chemical Engineering, Chemistry, Textile Industries and Colour Chemistry and Dyeing, and, in particular, the late Dr. Charles Ratcliffe Brotherton bequeathed £50,700 for the development of chemical engineering, which has been invested pending the commencement of building work. The latest gift of £21,000 to the Department of Coal Gas and Fuel Industries brings the total received during the past twelve months for new buildings for this Department to £81,660; the cost will be £615,000, of which the Government, through the University Grants Committee, will find £450,000. The steel framework for the new buildings is now in place, and it is hoped to occupy them during 1958–59.

The present scheme of development of the University includes a number of new buildings and is the most ambitious ever undertaken by the University. That for the Man-made Fibres Section of the Department of Textile Industries is in its final stages of completion, and is due to be opened by the Duke of Edinburgh on June 29 next. Good progress is being made with an extension of the buildings now occupied by the Departments of Physics and Chemistry, which

was started about twelve months ago, and it is anticipated that a new building for civil engineering and a new boiler house to serve the new buildings will be started on the Woodhouse Lane site in about twelve months; at the same time, the University will start the construction of a large new arts block at the Woodhouse Lane end of University Road, and it is planned to follow this after two years with new buildings for mechanical and electrical engineering. The cost of the whole scheme will be something in the region of £4 million, the greater part of which will no doubt come from the University Grants Committee. However, it will be necessary for the University to raise £500,000 towards the cost of these new buildings and their equipment, and up to date about £208,000 has been given or promised under deeds of covenant.

University Expenditure on Research

On May 31, in reply to questions in the House of Commons on the annual expenditure on fundamental scientific research by the University Grants Committee, Mr. H. Brooke, Financial Secretary to the Treasury, explained that grants are not normally earmarked for specific purposes and that research expenditure, therefore, is not separately distinguishable. He declined to comment as to the accuracy of the estimate that the amount is about £5 million and said that he is anxious not to embark on a policy of government earmarking of grants. The arrangements for the next quinquennium, he continued, will be the right moment to decide what future grants should be.

Mechanisms of Hearing and Balance

An up-to-date picture of some of the important topics of research on the ear and mechanisms of hearing and balance is given in a recent number of the *British Medical Bulletin* (12, No. 2 (May 1956): "Symposium on Neuro-Otology", pp. 70+4 plates; 15s.). Some new research techniques are described and illustrated in considerable detail. For example, by use of specially designed ultra-micro methods of analysis, it has been possible to estimate some of the electrolytes and organic fractions of the different labyrinthine fluids from small animals, even though the amount of fluid obtainable was sometimes as little as 0·1 μl. There are about a dozen separate articles in this number, and they include contributions on the comparative physiology of the otolith organs, fatigue and adaptation of hearing, and a fascinating chapter on the various types of inherited disorder of the labyrinth which are found in the different kinds of 'dancing' mice. This chapter ends with the sentence: "Further progress will largely depend on the degree of co-operation with specialists in related fields". It is just such publications as the present one which will increase that co-operation, by making clear to specialists in one field of research what is going on in related fields.

Rock Paintings and Engravings in Hyderabad

An interesting article has been prepared by Colonel D. H. Gordon and Dr. F. R. Allchin on some finds of rock paintings and engravings to the north of the Tungabhadra River in the Benakal Forest, Hyderabad (*Man*, July 1955). They were discovered by Leonard Munn, who photographed them and then copied them in colour on the photographs, and the dossier is now in the departmental library of the Indian Section, Victoria and Albert Museum, London. The drawings consist of human beings, horsemen, animals, signs, etc. Colonel Gordon, who has studied the rock-shelter art of the Central Provinces, India, for many years, has come to the conclusion that no part of this art dates back to a period earlier than the first half of the first millennium B.C., and that paintings and engravings continued to be made well into medieval times. The Benakal Forest art for the most part seems to belong to the dolmen period, as there are stone cists in the vicinity, with which they are probably to be associated. This would date some of the drawings to the first centuries B.C.; but a great deal of the art is clearly much later in date, as engravings have been found of Hindu sectarian symbols, scratchings and bruisings of umbrellas, as well as some drawings of temples.

Beef-Cattle Industry of Australia

The Commonwealth Scientific and Industrial Research Organization in Australia has published the results of a survey into the beef-cattle industry of the country (Bull. No. 278). The survey was carried out by W. A. Beattie, of the Division of Animal Health and Production of the Organization, and lasted from 1946 until 1952; it was designed to provide a background for the future planning of research. During the survey Beattie visited and examined all the beef-cattle producing areas of Australia and received co-operation from graziers' associations and primary producers. The survey aimed at determining and defining the structure of the industry as it has evolved in a variety of climatic environments on a large island continent, about one-third of which lies within the tropics. Attention was given to the conditions in each of the natural regions, action that may be taken to enable cattle to survive or thrive in them, the breeds of cattle available, methods of animal husbandry, disease and pest control, stock routes and transport, land tenure, labour, and the social structure of the industry.

Soil Science in India

In his presidential address to the Section of Agricultural Sciences of the forty-third Indian Science Congress, Dr. S. P. Raychaudhuri reviewed recent work in soil science in India with special reference to classification and survey. The first requirements of a basic improvement in Indian agriculture are a fuller understanding of the soils and a scientifically based programme for their better management. Indian scientists are tackling the innumerable problems presented by their soils on a broad front, and appear to be paying particular attention to the chemistry of soil fertility. Recent experience has shown remarkable responses to chemical fertilizers, and this offers immediate prospects of greatly increased yields. The majority of Indian soils are deficient in nitrogen, and the production as well as consumption of sulphate of ammonia are increasing steadily. Phosphate, by itself, is of more doubtful value, but increases response to nitrogen. Potash is generally adequate in Indian soils. Deficiencies of trace elements are reputed to be widespread, but little systematic study has been made of them. Much attention is being paid to salinity and alkalinity of irrigated soils, and soil surveys of irrigation areas have been of great value in preventing costly mistakes. Little work has so far been done on soil physics and microbiology, but the study of bacterial nitrogen fixation offers a promising field which is now being explored.

Besides irrigation surveys, fertility, land-use and soil-conservation surveys have been made in various parts of India, and this work is being extended. A basic system of classification for Indian soils is still lacking, and much field-work will have to be done before such a system can be devised. An All-Indian regional soil survey has been planned, and soil classes will be determined on a soil and geomorphological basis, with complementary chemical and physical determinations in the laboratory. Four regional centres are proposed in alluvial, black, red and laterite areas. The Indian Agricultural Research Institute now provides a two-year training course in soil survey.

Year Book of the Physical Society, 1955

The miscellaneous items which were previously published in the December issues of the Physical Society's *Proceedings* are now being published by the Society separately, entitled "Year Book of the Physical Society". The first such "Year Book", that for 1955, has been published (pp. 92; 10*s*.) and contains the following items: the texts of the 1955 presidential address, the 1954 Rutherford Memorial Lecture, the 39th Guthrie Lecture and the 18th Thomas Young Oration; abstracts of the lectures delivered by the recipients of the 31st Duddell Medal and the 10th Charles Vernon Boys Prize; obituary notices of five Fellows including Albert Einstein and G. F. C. Searle; and the report of the Council of the Society for 1954. In his Rutherford Lecture, Prof. P. M. S. Blackett describes his impressions of Rutherford and in particular refers to Rutherford's attitude to research and to the technical methods by which Rutherford achieved his astonishing output of important discoveries. He then discusses the problem of the proper relationship between the training of students in experimental technique and in theoretical knowledge, the difference between the present practice in British and American universities, and finally advances the practical solution of giving the experimental research worker an intense theoretical education in that part of theoretical physics which is narrowly centred on his experimental investigation. The Guthrie Lecture, entitled "Magnetism in Retrospect and Prospect", which was delivered by Prof. E. C. Stoner, consists of a survey of the advance in knowledge and understanding of the magnetic properties of matter during the past thirty years. Some of the outstanding experimental and theoretical problems are indicated, together with suggestions as to the kinds of experimental investigations required to elucidate the particular difficulties associated with metals. The basic data of colour-matching are the subject of the Thomas Young Oration, delivered by W. S. Stiles, of the National Physical Laboratory, Teddington, and a new determination of the colour-matching functions is described.

The Physics of Gas Flow at Very High Speeds

The Summer Meeting of the Physical Society will be held this year in the University of Manchester during July 16–17, and will be concerned with the flow of air and other gases at speeds so high that changes in kinetic energy are comparable with the energy required to produce interesting physical changes, such as dissociation, ionization and substantial emission of radiation. The implications for the aerodynamics of man-made projectiles travelling at extreme speeds, and also of meteors, will be included in the discussion. The shock tube will be discussed at length, both as regards design and instrumentation for use with very strong shock waves, and in connexion with the results so far discovered by its use. Prof. M. J. Lighthill, Department of Mathematics, University of Manchester, is organizing the sessions. Among those taking part in this meeting are: Mr. J. G. Davies (Jodrell Bank Experimental Station); Dr. Wayland Griffith (Palmer Physical Laboratory, Princeton University); Dr. D. W. Holder and staff (High-speed Section, Aerodynamics Division, National Physical Laboratory); Prof. M. J. Lighthill (Manchester); Prof. N. F. Mott (Cambridge); H. K. Zienkiewicz (Manchester). Non-members of the Society will be able to attend the meeting; inquiries should be addressed to the Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7, marked for the attention of Miss Miles.

Commonwealth Fund Grants for Medical Education in the United States

The Commonwealth Fund, New York, has recently given grants of 4,850,000 dollars to seven university medical schools in the United States for use in whatever ways the schools consider most effective to improve their programmes of medical education. These grants, which are in addition to the sums expended for specific medical education projects during the fiscal year 1955–56, have been drawn from the Fund's capital assets and current income, and they bring to a total of 12,600,000 dollars the amount of such gifts made by the Fund since November 1955 to help the medical schools in the United States. The schools receiving the new grants are: Albany Medical College of Union University, 500,000 dollars; George Washington University School of Medicine, 500,000 dollars; University of Pennsylvania School of Medicine, 500,000 dollars; Boston University School of Medicine, 600,000 dollars; University of Rochester School of Medicine and Dentistry, 750,000 dollars; Johns Hopkins University School of Medicine, 1,000,000 dollars; and Stanford University School of Medicine, 1,000,000 dollars. During recent years the primary interests of the Commonwealth Fund have been in the field of health, particularly in medical education, medical research and community health services.

Institute of Biology: London Branch

The London Branch of the Institute of Biology held its annual conversazione on May 10 at the South-West Essex Technical College, Walthamstow, by courtesy of the principal of the College, Dr. H. Lowery. Guests were received by Dr. Lowery and Dr. H. O. J. Collier, president of the London Branch. Many biological topics were represented, from seals to bacteria: anatomy, ecology, ethology, microbiology, parasitology, pharmacognosy, physiology and biochemistry, and genetics were all represented. An interesting section was grouped together under "Improvisation and Gadgetry"; this was a valuable idea. The research worker is so often helped if he or one of his colleagues is versed in the art of gadget-making. It is often not simply a matter of 'making do', but of constructing something to do a job when no suitable apparatus already exists. Films and slides on four different topics were exhibited. It is customary for a guest society to be invited to make an exhibit; this year it was the Royal Institution, which displayed various historic documents and

objects. The Branch also permits each year one firm of suppliers of apparatus to provide an exhibit. The layout of the exhibits was admirable, the Great Hall of the College giving ample space for complete inspection.

Symposium in Geneva on High-Energy Physics

THE European Organization for Nuclear Research is holding an international symposium on "High-Energy Physics" during June 11–23 in the Institute of Physics of the University of Geneva. Some three hundred scientific workers from twenty countries will attend the symposium; they will include approximately one hundred and sixty from the twelve member States of the Organization, about sixty each from the United States and the U.S.S.R., and a number from Australia, Canada, Czechoslovakia, India, Japan and Spain. In addition, about a hundred members of the scientific staff of the Organization will be participating. During the first week the main discussions at the symposium will be on novel features in the design and techniques of high-energy particle accelerators; the first few days of the second week will be devoted to newly developed techniques for the detection and measurement of fast particles, such as bubble chambers and over-compression cloud chambers, and during the latter part of the week π-mesons and the anti-proton will be considered.

Announcements

THE Geological Society of London has awarded the R. H. Worth Prize for 1955 to Mr. James Wright, and the Prize for 1956 to Dr. C. T. Trechmann; these Prizes are from a fund established under the will of the late Richard Hansford Worth, of Plymouth, "to provide a prize or prizes for the encouragement of amateur geological research". The Daniel Pidgeon Fund for 1956 of the Society has been awarded to Dr. K. A. Joysey, of the Department of Zoology, University of Cambridge, who is studying the variation in living and fossil echinoid species in order to assess the stratigraphic and systematic significance of this variation.

THE following, among others, have been appointed to chairs in the newly established Medical School of the University of Western Australia, Perth: *Anatomy*, Dr. D. C. Sinclair, University demonstrator in human anatomy, Oxford; *Medicine*, Dr. E. G. Saint, director of the Clinical Research Unit in the Royal Perth Hospital, Western Australia, and formerly of the Department of Industrial Health, King's College, Newcastle upon Tyne; *Microbiology*, Dr. N. F. Stanley, director of the Institute of Epidemiology and Preventive Medicine, Prince Henry Hospital, Adelaide.

THE College of Technology, Bristol, in collaboration with the Regional Council for Further Education for the South West, has arranged a course during July 6–7 on "The Applications of Radioactive Isotopes in Industry and their Uses as Tracers". The course is designed for chemists, engineers and technologists from industry. The fee, exclusive of accommodation, is one guinea. Further information can be obtained from the Department of Chemistry and Biology, College of Technology, Bristol 1.

A SUMMER course on "Oilfield Reservoir Engineering" will be held in the University of Birmingham during July 2–28. The course, which will be residential, will comprise lectures by members of the Petroleum Production Department of the University and specialist lecturers from industry, including, in particular, the British Petroleum Co., Ltd. Further information can be obtained from H. Gilmour, Petroleum Production Department, University, Edgbaston, Birmingham 15.

THE Association of Applied Biologists will hold its summer meeting in Northern Ireland during July 19–21. After the reading of a number of papers on July 20 at The Queen's University of Belfast, the succeeding days will be devoted to tours of the Counties of Antrim, Londonderry, Down and Armagh. Further information can be obtained from the honorary local secretary, Dr. J. Colhoun, Department of Mycology and Plant Pathology, The Queen's University, Belfast.

A TWO-DAY summer meeting of the Royal Meteorological Society will be held in the University College of Wales, Aberystwyth, during July 26–28. On the first day there will be papers on ionization methods of measuring air density and a discussion on airflow, and on the next day papers on aspects of local climatology will be followed by a discussion on orographic effects in relation to rainfall. Further information can be obtained from the Assistant Secretary of the Society at 49 Cromwell Road, London, S.W.7.

A CONFERENCE on "Magnetism and Magnetic Materials", organized by the American Institute of Electrical Engineers in co-operation with the American Physical Society, the American Institute of Mining and Metallurgical Engineers, and the Institute of Radio Engineers, will be held in Boston during October 16–18. Those who wish to read papers should send in the titles by June 15, and abstracts by August 1, to T. O. Paine, Measurements Laboratory, General Electric Company, West Lynn, Mass., from whom further information can be obtained.

A SYMPOSIUM on "X-Ray Microscopy and Microradiography", sponsored by the International Union of Pure and Applied Physics, will be held in the Cavendish Laboratory, Cambridge, during August 16–21. The symposium is intended to be a gathering of those with some direct experience or interest, rather than a large public conference, and primary emphasis will be placed on the physical methods, in theory and practice. Sessions are planned on the reflexion, contact and projection methods, respectively; sessions will also be devoted to applications in biology, medicine, metallurgy and other fields, including industrial applications. Further information can be obtained from Dr. W. C. Nixon, Cavendish Laboratory, Cambridge.

THE eleventh annual conference and exhibition of the Instrument Society of America will be held in New York during September 17–21. The exhibition, which will be in the Exhibition Hall of the New York Coliseum, is for manufacturers and their representatives to display their range of instruments and control apparatus used in scientific, technological and engineering work; in particular, emphasis will be placed this year on the application of instruments to automation in industry. Further information can be obtained from the exhibition manager, Fred J. Tabery, Eleventh Annual Instrument-Automation Conference and Exhibit, 250 West 57th Street, New York City.

THE PRESENTATION OF SCIENCE TO THE PUBLIC

"WHY do scientists want to communicate science to the public, while lawyers do not show any such desire to communicate law?" To answer this question, asked by Dr. H. J. T. Ellingham in the recent symposium on "The Presentation of Science to the Public", is to explain why it was organized. Unlike lawyers or doctors, scientists work in comparative isolation from other people, and so they are apt to feel, as Dr. Ellingham put it, a little misunderstood. Scientists are aware that the general public sometimes fears or dislikes science, which makes some of them keener to explain how their work may ultimately be valuable to everybody. Knowing, too, that theirs is a social activity, which depends in the end on public support, some scientists believe that they owe society an account of their doings. If they themselves do not help to give this account, then others less informed may give a misleading version. Finally, the popularization of science helps to recruit young people to a scientific career and to incline their elders to accept scientific findings.

For many years, therefore, scientists have felt a need to inform the public about science, and a few of those who responded to this feeling in the past, such as Thomas Henry Huxley, achieved a skill that can scarcely be bettered. New discoveries and inventions, new ways of presenting information and a new public require the problem to be tackled over again in every generation.

For such reasons the Institute of Biology (London Branch), the Royal Institute of Chemistry (London Section) and the Institute of Physics (London and Home Counties Branch) jointly organized a symposium on the subject, which was held on March 21 in the Senate House of the University of London under the chairmanship of Mr. A. L. Bacharach. The symposium was opened with papers by three experts in different media of presentation: Dr. Archie Clow (sound radio), Mr. A. W. Haslett (printed word) and Mr. James McCloy (television).

Dr. Clow distinguished two main methods of communicating science by sound radio—the talk and the "dramatized feature". The talk, with which he has been mainly concerned, presents the scientist together with the science, and the requirements for its success are four: something to say, a valid reason for telling the public, imaginative treatment, and ability of the scientist to perform. Since radio is paradoxically an intimate medium, the art of putting good conversational English into the script is fundamental. A radio talk differs from a printed article not only in style, but also because the listener cannot go back to consider again what he has not understood. The order of presentation of a radio script has to be very carefully planned: it should arrest the listener's attention with the first sentence, it should never allow him to lose the thread, and repetition is no sin.

Dr. Clow said that the knowledge of the listener should not be over-estimated. Of a group of 21-year old soldiers, the bulk knew that microbes cause disease, less than half that living organisms cause fermentation of beer, and about one in twenty that they turn milk sour.

Mr. Haslett discussed both readers and authors. Of readers, he said that they need interest, knowledge and general education. The question of who should write for these rather rare characters depends on the technical level of treatment in a channel of communication which begins with a letter in *Nature* and ends with a man in a public house. On highly technical levels the scientist, who knows more about the subject but less about how to explain it, should be the author; but at the other end of the scale, the professional science writer is essential. In between, both should collaborate.

Advising on how to write science, Mr. Haslett leaned heavily on Fellows of the Royal Society, individually and collectively. He passed on their recommendations to use short words and simple sentences, not to write for the half-dozen people in the world specially interested, not to be afraid of making a fool of oneself and to remember that no one really likes an equation. He also stressed the value of giving an honest account of how a discovery has been made, if by chance or through error, rather than tidying it up to look logical.

Mr. McCloy said that a television programme looks like film but is the child of radio. It differs from film in being a live act, in which the commentator visibly takes part. Science is a 'natural' for television, since experiments, demonstrations, models, charts, films, discussions and comment can all be built into one programme. As science programmes reach an audience of several millions, they have to be easily understood. It follows that a good science television broadcast is difficult to give and easy to receive.

No main speaker dealt with the role of museums; but this gap was filled by Dr. F. A. B. Ward, who pointed out in the discussion that museums have the advantages of operating in three dimensions, and of being able to present historic notebooks, apparatus and machines.

Discussion centred mainly on what may be called the problem of 'resistance', which has two sides: resistance of the public to understanding science, and resistance of the scientist to telling the public about it. As might be expected, the scientists joining in the discussion were more aware of resistance on the part of the public, while the professional presenters of science were at least equally concerned at the resistance of the scientists themselves.

The discussion was opened by one member of each participating Institute. All the openers considered how science may be presented in a way that people can easily take in. Speaking from long experience, Dr. Maurice Burton advocated stressing the personal note and telling a story. Dr. Kenneth Pankhurst preferred the word 'communication' to 'presentation', because the former implies a certain intimacy between the giver and taker of information. Sincerity and enthusiasm are essential, but they must be accompanied by skill in the medium used. Mr. Geoffrey Parr deplored inadequate illustration in popular science books; Beatrix Potter achieved the ideal relationship of words to pictures in "Peter Rabbit", and, as in "Peter Rabbit", illustrations should be coloured.

Mr. T. A. Margerison, on behalf of the Association of British Science Writers, welcomed the symposium, which he thought was the first of its type. He said there can be no question of the *élite* scientist spreading

scientific enlightenment to the lay public, because the problem of spreading science among scientists is just as urgent as that of spreading it among the public at large.

Mr. Maurice Goldsmith discussed the resistance of scientists to appearing on television. In producing a weekly television magazine, he has found that a proportion of scientists hesitate to co-operate. Some are needlessly afraid of being used for commercial ends, others feel it beneath their dignity to appear on television or perhaps fear the disparagement of their colleagues, while some do not feel that anything can be achieved in the space of four minutes. He believes that scientists do not realize that 'cathode ray tube time' is quite different from any other form of time they know. It provides the opportunity for a new experiment in the popularization of science, enabling the scientist to put forward what he wants to say to an audience of five million.

The communication of science to scientists and to the public may be regarded as extensions of one another. It follows, as Mr. A. L. Bacharach[1] pointed out in a preceding symposium on "The Communication of Biological Knowledge", that the same underlying principles apply to the communication of science, whatever the audience. No mind, however good, can take in unfamiliar things without effort. The scientist, familiar with his own special field, should therefore present it to others (technically qualified or not) in such a way that the effort required is not beyond their capacities. Bad presentation on any level should be suspected as a cloak for muddled thinking or poor research. The present symposium, which showed that a representative sample of scientists recognizes such truths, may become a small landmark.

H. O. J. COLLIER

[1] Bacharach, A. L., *J. Inst. Biol.*, **3**, 57 (1956).

LOW-TEMPERATURE CRYSTALLOGRAPHY

MEETING IN OXFORD

THE first joint conference of the X-Ray Analysis Group of the Institute of Physics and of the Low Temperature Group of the Physical Society was held at the Clarendon Laboratory, Oxford, during April 12–13 under the joint chairmanship of Dr. K. Mendelssohn and Mr. H. P. Rooksby. The subject of the conference was "Low-Temperature Crystallography", and the invited speakers dealt with both the technical aspects of X-ray work at temperatures down to 1° K. and also with the actual type of experiments where a low temperature is an advantage.

The first session was opened with an introductory paper by Sir Francis Simon (Clarendon Laboratory, Oxford). In this he emphasized that transitions which were not thought possible a few years ago do take place at low temperatures and that X-rays are one method of investigating the nature of these transitions. X-ray analysis can be used for giving information on the state of order of a system, this order being determined by the influence of the interaction forces between the components of a system. Order can exist only at low temperatures, and perfect order is only possible at the absolute zero. What we mean by a low temperature depends, of course, on the system we are considering; for diamond 1,000° K. is low, whereas for hydrogen 50° K. is high. X-rays can also give information on the form of the vibrational spectrum, and a combination of X-ray and thermal data should prove useful in entropy calculations based on the third law.

Dr. M. Blackman (Imperial College, London) dealt with the theoretical aspects of the effect of temperature on the reflexion of X-rays. He showed that from a generalized form of the Debye–Waller theory for a complex crystal, a characteristic temperature Θ_x can be calculated, and this can be compared with the characteristic temperature, Θ_{el}, derived from elasticity theory. The theoretical value of the ratio Θ_x/Θ_{el} for sodium chloride and potassium chloride did not agree with the ratio obtained from experimental results, and this discrepancy cannot, as yet, be resolved.

In a paper on a theoretical study of the variation of vibration amplitudes with temperature in some molecular crystals, Dr. D. W. J. Cruickshank (University of Leeds) discussed how the root-mean-square amplitudes of the translational and angular oscillations in benzene and anthracene have been determined by three-dimensional Fourier refinements with anisotropic parameters. From these amplitudes the various characteristic temperatures have been determined, and the temperature variation of the vibrational and rotational oscillations has been calculated. These show that, for studying fine details of electron density, it is much more advantageous to take measurements at 90° K. (or better still at ~ 20° K.) than at room temperature, but that little extra is gained in this particular work by taking readings below 20° K.

Dame Kathleen Lonsdale (University College, London), in her paper on the determination of Debye factors by intensity measurements at low temperatures, showed that there are two independent ways of determining the Debye factors for crystal diffraction spectra: one is the original method of comparing the intensities at different temperatures with due regard to the existence of zero-point motion; the other uses the intensities at one temperature only, taking account of the positions and motions of the atoms as determined through a complete structure analysis. These methods have been compared from data on urea, and they have been shown to agree better than might have been expected, bearing in mind the possibility of change of atomic parameters with temperature.

Discussing low-temperature X-ray work on alkali metals and alloys, Prof. C. S. Barrett (University of Chicago) described an X-ray spectrometer in which metals can be cold-worked at temperatures down to 5° K. The X-ray studies show that, down to this temperature, lithium and sodium are the only alkali metals which partially transform on cooling. This transition is from the body-centred cubic to the hexagonal close-packed structure, the axial ratio in the hexagonal phase being very close to 1·633, the theoretical value for close packing. The transformation in lithium occurs at 70° K. On cold-working the lithium at low temperatures, there is a further transition, this time to the face-centred cubic structure. This does not appear to occur when sodium is cold-worked; but a similar transition does occur for solid solutions of magnesium in lithium.

Dr. W. B. Pearson (National Research Council, Ottawa) described X-ray cameras which have been built for use down to liquid-helium temperatures. These have been designed to have an accuracy of

one part in 40,000, which is necessary for Debye–Scherrer photography if useful measurements of the change in lattice spacings with temperature are to be obtained. Other work to be done with these cameras includes the examination of structure changes in metals which are strained or subjected to high pressures at low temperatures.

The second session of the conference was opened with a paper by Prof. W. N. Lipscomb (University of Minnesota), who gave a general review of the techniques of low-temperature crystallography with particular reference to work on single crystals. After sketching briefly the history of single-crystal studies, he described the various methods of making single crystals for X-ray work. Many of these are gaseous or liquid at room temperature, and they require special methods for their production, the most common method being to crystallize the substance in a 'Pyrex' glass capillary. He also emphasized the need for keeping the production of frost down to a minimum, which can be done either by air-conditioning or by using a stream of dry air directed on to the apparatus. The consumption of liquid nitrogen, for cooling the specimen, can be quite considerable; for maintaining the specimen at −180° C. four litres per hour are required. Later speakers at the meeting, however, described cooling methods in which the consumption is much lower. Prof. Lipscomb's has been used for the completion of *hkl* data in B_5H_{11} and also for the investigation of transitions in ethylene chloride, hydrogen cyanide and nitrogen trioxide.

Dr. Aafje Vos (Laboratory of Inorganic and Physical Chemistry, Groningen) gave a review of recent Dutch X-ray work at low temperatures. This type of research has been done both at Amsterdam and at Groningen. In Amsterdam measurements on the electron-density projections of phthalic acid at −150° C. show an appreciable gain in resolution over those taken at room temperature. Low temperatures were also used in the investigation of the molecular compound of symmetric trinitrobenzene and benzene. At room temperature, pictures of the triclinic crystals showed a diffuse background with approximately hexagonal symmetry. This diffuse background disappeared completely at −150° C. The effect is probably due to independent thermal vibration of the individual molecules, and it seems most probable that the benzene molecules are responsible. In Groningen the crystal structure of 1,8-diphenyl-1,3,5,7-octatetraene has been examined at −100° C. in order to increase the accuracy of the determination of the bond-lengths. Standard deviations of about 0·003 A. and 0·04 A. were obtained for the co-ordinates of the carbon and hydrogen atoms, respectively. The use of low-temperature measurements has probably decreased the inaccuracy of the bond-lengths by a factor of two, and this is important if the experimental values are to be compared with theory. While in most of this work the specimens were cooled by a stream of cold air, another technique was described in which liquid nitrogen was dropped directly on to the specimen to cool it. In this apparatus the consumption of liquid nitrogen was 0·5 lit./hr.

Recent low-temperature crystallographic studies in France were described by Dr. A. J. Richard (Kodak-Pathé, Paris). This work was done at the Laboratoire Central des Services Chimiques de l'État. A Weissenberg camera was used in the temperature range −160° to 20° C., the specimen being cooled by nitrogen gas obtained by boiling liquid nitrogen with an electric heater. The temperature variation over several hours was not more than five degrees, and during a period of one hour it was less than one degree. Structure studies were undertaken on nitric acid and its one- and three-molecule hydrates (V. Luzzati); one-, two-, three-, four-, five- and seven-molecule hydrates of sodium hydroxide (P. W. Hemily); sulphuric acid and several compounds of the tertiary system nitrogen pentoxide–sulphur trioxide–water (R. Pascard); salicylic anhydride (Mme. P. Bourre); and acetaldehyde (A. J. Richard).

Another apparatus for maintaining specimens at low temperatures was described by Dr. J. H. Robertson (University of Leeds). In this the cold gas stream is again used for cooling, in order to give the minimum of interference with the X-rays, and by careful design the consumption of liquid nitrogen has been reduced to 1/7 lit./hr. The gas flow is very steady, the variation being only about 1 per cent over a period of 4½ hr. While the apparatus has not as yet been used with liquid hydrogen, it is hoped that it will be satisfactory in the temperature range down to 20° K.

Mr. M. H. Francombe (Research Laboratories, General Electric Co., Ltd., Wembley) gave a paper on the application of low-temperature powder photography to studies of magnetic and dielectric phenomena. A 19-cm. camera which incorporates a gas cooling system for the specimen was described and exhibited. The apparatus has been used for studying structural changes which occur in antiferromagnetic, ferrimagnetic and ferroelectric powders.

A paper by Dr. J. A. S. Smith (University of Leeds) showed how nuclear magnetic resonance measurements at low temperatures can give additional information in structural analysis. A general review of nuclear magnetic resonance methods was given, taking as an example work on benzene and ammonium chloride in which the behaviour below and above their nuclear magnetic resonance transitions was compared. From the variation of the line-width and relaxation-time in and above the transition region, the predominant molecular motions in the crystals could be investigated. In another series of experiments low temperatures were used to remove the narrowing effects of molecular motion on the line-width. This work has been done with sodium borohydride, hydrazinium oxalates and several hydrates. The results seem to cast further doubt on the existence of the ion H_4O^{++}.

Dr. C. H. Shaw (Ohio State University) read a paper on an X-ray determination of the structure of liquid helium. This work, which was done in collaboration with W. L. Gordon and J. G. Daunt, used proportional counter techniques for determining the intensity of the X-rays scattered by the liquid helium. Beryllium windows, 0·002 in. thick, were used to admit the X-rays through the vacuum jacket into the cryostat. The background count was reduced to 4 per minute. At scattering angles greater than 60°, no difference was found in the form of the diffraction patterns at 1·4 and 4·2° K. The low-angle results, however, which were taken at 1·4, 2·4 and 4·2°-K., showed that there was a change in correlation number as the temperature was reduced, but that there seemed to be no definite change associated with the lambda point. X-ray measurements on tungsten showed that there was a maximum in the characteristic temperature, Θ, at 17° K. The existence of

such a maximum can also be derived from measurements of specific heat. In the discussion, Dr. M. Blackman stated that on theoretical grounds this maximum is very difficult to explain.

In a paper on measurement of lattice parameters and thermal expansion at low temperatures, Prof. G. O. Jones (Queen Mary College, London) described work done in collaboration with B. S. Figgins and D. P. Riley. The apparatus was designed so that only the specimen was at the low temperature, and an accuracy of 1 in 10^4 in the measurement of the lattice parameter could be achieved. The temperature could be kept constant to 0·05 deg. at the lowest temperatures. So far, measurements of the lattice parameter (and hence of the thermal expansion) of aluminium have been carried out between 20° and 125° K. The results confirm earlier work of Bijl and Pullan, that at low temperatures there is a considerable deviation from Grüneisen's law. Measurements on solid argon are also in progress. In connexion with this work, Dr. E. R. Dobbs (Queen Mary College, London) gave a short contribution in which he described a simple back-reflexion camera for experiments on solidified gases down to 77° K. This has been used for work on solid krypton.

Mme. L. Couture (Centre National de la Recherche Scientifique, Bellevue) described work, done in collaboration with P. Jacquinot and I. Tsujikawa, on optical observations of transition in crystalline hydrates at low temperatures. The experiments showed that the absorption spectra of some substances (in particular, certain of the alums) changed at low temperatures, and these results were compared with corresponding changes which had been found in measurements of paramagnetic resonance. Complete agreement between paramagnetic and optical results was not achieved, but nevertheless the optical experiments confirmed that changes in crystalline structure do occur at low temperatures, especially in some of the chromium alums.

The conference showed that, while a large amount of X-ray work is already being done at temperatures down to 77° K., using liquid nitrogen as the coolant, not very many experiments have been done at lower temperatures, using liquid hydrogen or liquid helium as the coolant. There is still a very wide field of research open to anyone who has the necessary cryogenic facilities. In addition to the lectures already described, an evening discourse, entitled "Molecular Crystals", was given by Prof. J. D. Bernal (Birkbeck College, London).

In a meeting of the X-Ray Analysis Group which preceded the joint conference, a discussion was held on the collection and classification of crystallographic data for determinative and reference purposes. The discussion was opened with contributions by Dr. J. W. Hughes (University College, Cardiff) on the A.S.T.M. index, Prof. E. G. Cox (University of Leeds) on the single-crystal index, Dr. M. H. Hey (British Museum) on the Barker index of crystals, and Dr. L. E. Sutton (University of Oxford) on a bond-length index. Dr. W. B. Pearson (Ottawa) gave details of the index of metals and alloys which should soon be available. Several speakers in this discussion emphasized the need for research workers to send in their crystallographic and X-ray data to the compilers of the various indexes. Many of the data are obtained as an incidental part of some other research, and very often they are not published. Hence, they are overlooked when reference books are being written.

A full account of the conference will be given in the *British Journal of Applied Physics*. The next conference of the X-Ray Analysis Group will be held in London during November 16–17; two sessions will be devoted to biological structures, and one session to computational methods.

H. M. Rosenberg

DIGITAL COMPUTER TECHNIQUES

A CONVENTION on "Digital Computer Techniques" was held in London at the Institution of Electrical Engineers during April 9–14, at which more than fourteen hundred persons attended, including 127 delegates from overseas countries. These figures emphasize the rapid growth of interest in this field, since at a similar convention, held three years ago, only two hundred in all were present. On the evening of April 9, after the convention had been opened by the president of the Institution, Sir George Nelson, an inaugural address was given by the president of the Royal Society, Sir Cyril Hinshelwood, and this was followed by an introductory lecture by Prof. F. C. Williams. During the next three days, fifty-eight papers were read. The papers had been divided into two groups: those of general interest, and those of interest to specialists. Normally, a general and a specialist session were held simultaneously, so that in this way both the non-expert and specialist were satisfactorily accommodated. On the last two days of the convention, visits to typical computer installations were made. These visits had been arranged with the co-operation of commercial companies, government establishments and universities; nearly nine hundred delegates availed themselves of these opportunities.

In his address, Sir Cyril Hinshelwood referred to the diverse lines of thought which have been successfully combined in the computing machine of to-day. Essential contributions have come from the theory of numbers, the relations between mathematics and logic, the discovery of various electric and magnetic phenomena, and the invention of the thermionic valve. He emphasized that the philosophy, in this case of machine design, preceded the actual construction and thus was not an afterthought about results, as it sometimes is. Having introduced the computing machine in this way, he then turned to view and speculate upon the interesting and exciting panorama which is beginning to unfold before us. On the scientific side there is now the prospect of solution of hitherto intractable problems; in the business world the mechanization of all kinds of clerical work and accountancy can be contemplated; and in industry the process of automatic control can be improved and carried a further step towards the final goal of complete 'automation'. The use of machines in this way must effect a displacement of man-power, and could amount to another industrial revolution. Sir Cyril Hinshelwood expressed the hope that any necessary redistribution of labour would be carried out without any serious results from the human and economic points of view. Finally, after a brief excursion into the seemingly age-old problems of 'Can machines think?' and the 'machine–brain analogy', he concluded by expressing his admiration of this work and his great confidence in its future.

In his lecture, Prof. Williams indicated the rapid development in the field of digital computers by con-

sidering the history of a typical computer installation, namely, that at the University of Manchester. Parallel developments have occurred elsewhere, but he selected this installation because of his familiarity with it. During the period 1946–56, two large-scale machines and one experimental transistor machine have been constructed. A commercial version of the first large-scale machine has been in continuous operation since 1951 and has now completed some 17,500 hours of useful computation. During this period, thirty-four different groups of users drawn from other universities, government establishments and industrial firms have operated the machine. Furthermore, 104 people have been trained to use the machine, and sixty-six scientific papers have been published using machine results. A commercial version of the second large-scale machine will be in operation at the University near the end of this year.

Prof. Williams went on to say that machines are attractive for many reasons: first, they can be universal so that they are capable of solving a large variety of problems; secondly, they are automatic, so that only a small amount of human intervention is needed; and finally, they are very fast, so that computation times are cut and, what is more important, many calculations previously impossible now become feasible. Machines are also relatively error-free; at the present time, on an average the machine makes one mistake in 4 million operations. What human being could compare! Moreover, though the hire of a machine appears expensive, in terms of cost per operation a machine is fifty times cheaper than a human computer would be. This latter comparison is only applicable if the machine is fully employed.

Looking a short distance into the future, Prof. Williams forecast machines which would be simpler to use, smaller in size, more economical in terms of power consumption, and also more reliable. However, the major steps, he stated, would be in the realization of the potentialities of these machines, and so a rapid expansion in the application of machines would result to the ultimate benefit of all. He concluded his lecture with the following remarks: "If at this juncture we are swollen headed with the sense of our achievements, or alternatively despair of further improvements, we have only to consider, for example, a rose seed. This very small particle contains all the data necessary for the manufacture of an unending and ever increasing supply of roses".

All the sessions on April 10 were of a mathematical nature and thus more of interest to the machine user. The topics of discussion in the specialist sessions were numerical analysis and logical design, five papers being presented. Computer applications were discussed in the general sessions, these being divided up into three sections: engineering and scientific calculation; business applications; and industrial control. Many papers were presented, the variety in the subject-matter illustrating immediately the universal nature of these machines. Topics ranged from testing the design of a proton synchrotron, to payroll calculations and the exploration of functional relationships in industrial processes. The main item of discussion during the day was a vital one, namely, that of machine reliability. Dr. I. J. Faulkner placed this particular problem in its right perspective, when he stated that progress towards a machine possessing a reliability of 100 per cent is very desirable, but no piece of equipment, whether electronic or not, yet possesses this feature. Further, until absolute perfection is guaranteed, systems dependent on a machine will have to be designed to 'fail safe'. In the light of these remarks, machines at the present time are adequately reliable for a great deal of progress to be made. Indeed, if the argument of waiting for more reliable machines were adopted, nothing would be achieved for a very long time.

The general sessions on April 11 were devoted to machines existing or in the process of construction in Great Britain. Two large-scale computing machines are now commercially available. One is the 'Deuce', which possesses a high-speed store of approximately 12,000 binary digits located in mercury delay-lines. A magnetic drum-type store of capacity 260,000 digits is also provided which has electronic selection of a block of sixteen heads. Further blocks of these heads are selected by means of a novel mechanical system. Input and output facilities are provided by means of punched cards. In the second machine, 'Mercury' magnetic core storage is used, and this high-speed memory contains 40,000 binary digits. Further storage of 650,000 binary digits is divided over four magnetic drums. Selection of the heads on these drums is entirely electronic. An interesting feature of this machine is its power to carry out 'floating point' arithmetic in a completely automatic manner. Input and output facilities are at the present time by way of teletype tape. In addition to these two machines, numerous smaller-scale models are being constructed.

The two specialist sessions, one on rapid access storage and the other on magnetic tape systems, also aroused great interest. At the first session Mr. N. H. Taylor, of the Massachusetts Institute of Technology, reviewed the history of the magnetic core store and gave an account of its present development in the United States. The climax was reached when he stated that a two-million digit store is well under construction at the Institute. In Britain the cost of the cores alone would be £80,000, which is greater than the complete cost of either of the machines already mentioned.

In the second session, two papers devoted to the development of tape systems moving the tape at speeds of the order of 100 in./sec. and with digit packing densities of approximately 100 digits/in. were presented. The tape is capable of moving in either direction and can accelerate up to full speed in the order of 15 m.sec. A further paper in this session discussed the design and operation of a head which is capable of reading digits off a tape even when this tape is stationary. At the present state of development, the head can identify digits with a packing density of 50 digits/in. The discussion revealed that many people realize the potentialities of this type of head.

At the first general session on the last day the design and construction of two point-contact transistor machines, one at Harwell and the other at the University of Manchester, were discussed. These operate at digit frequencies of about 100 kc./s. It is apparent that transistor development in Britain lags far behind that in the United States, since the latter already have transistor prototype machines functioning at a digit frequency of 5 Mc./s. At a subsequent specialist session, a lively debate took place on two papers utilizing techniques based on the combination of magnetic cores and junction transistors.

Other sessions on analogue/digital conversion and circuit techniques and components were held, but

the main interest was aroused in a session discussing the computer in a non-arithmetic role. Here papers were presented on language translation, the playing of games and, finally, character recognition. A contribution was made by the U.S.S.R. delegates, who have been carrying out English to Russian translation on one of their machines since early in 1955. They assured their audience that the result was good Russian.

In conclusion, it can be stated that the convention brought together a large amount of detailed and expert technical knowledge in the various aspects of digital computers and their use. There is no doubt, too, that it proved valuable in some way to all who attended. The complete proceedings of the convention, containing the addresses, lectures, full text of all papers, and reports on the discussions, will be published in three issues as a supplement to Part *B* of the *Proceedings of the Institution of Electrical Engineers*.

DAVID B. G. EDWARDS

BRITISH AGRICULTURAL HISTORY SOCIETY

ANNUAL MEETING

SINCE it was founded in 1953, the British Agricultural History Society has held its annual meeting near Easter, and this year's meeting was at the Florence Nightingale Hall, University of Nottingham, on April 13. Officially, the annual general meeting is confined to one day—a business meeting in the morning followed by one or more papers read by members, and either more papers in the afternoon, or a visit to some point of interest. In addition, however, an after-dinner lecture was given in the evening of the previous day by Mr. John W. J. Higgs, curator of the Museum of Rural Life, Reading, and also honorary secretary of the Society. His lecture, which dealt with the problems involved in the identification and preservation of agricultural exhibits, was pleasantly informal and illustrated with lantern-slides. From the pictures it was clear that it is often difficult to discern the use of an object sent in, and even more so to date it. One such question arose out of the discovery on English farms of numbers of ox-shoes, or cues. It seems quite unlikely that bullocks on a farm would ever be shod, even if they were used for draught purposes, though they might be if used on roads. The explanation is probably that the animals were shoed before being brought from distant breeding-areas—Wales and Scotland, for example—and that it was not worth taking off any that remained on after the journey; eventually the shoes wore off and were dropped on the farm where the beasts were grazed. Many other similarly perplexing questions arise.

After the business meeting on April 13, the rest of the morning was occupied by two lectures, the first of which, given by Malcolm Gray, lecturer in economics in the University College of North Wales, Bangor, was on the "Consolidation of the Crofting System, 1750–1850". The story is extremely complex. Until 1815, population increased in the Western Highlands and Islands, and the number of crofts went up. Many were quite minute, only an acre or two. Attempts were made to meet the demand for land by rearranging the holdings, a kind of enclosure, but very different from the work done under Enclosure Acts in England. The kelp industry and the linen industry did a good deal to ease conditions, and the introduction of the potato was a boon. It provided more food from a given area than a grain crop. But it was attacked by disease, and the kelp industry lost ground in face of the competition of imported potash. These two factors, and a number of others, helped to make it difficult for the crofting system to survive. Dr. W. G. Hoskins, reader in economic history in the University of Oxford, gave the second lecture, which was on "Sheep Farming in Saxon England". There is only limited and scattered evidence on which to base such a lecture. A little is supplied by archæology, some by the study of place names, and some by a few documents. From these sources Dr. Hoskins has deduced the distribution of sheep in Anglo-Saxon England, and has estimated the total number as being about six million, or three or four sheep to each human being.

In the afternoon a visit was paid to the open fields at Laxton, now owned and preserved by the Government. Dr. J. D. Chambers, of the University of Nottingham, who is well known for his studies of the eighteenth century, acted as guide, and Mr. Rose, bailiff of the Manor, showed the fields.

THE PLACE OF UNIVERSITIES IN AUSTRALIA

THE Australian Vice-Chancellors' Committee has published in pamphlet form a symposium of papers on "The Place of the Australian University in the Community and Post-Graduate Studies in the Australian Universities", which were delivered during August 11–12, 1955, at a Commonwealth Inter-University Conference arranged in Australia by the Association of Universities of the British Commonwealth and the Australian Vice-Chancellors' Committee*. The first of these papers, by Prof. P. H. Partridge, on the Australian universities and Governments, gives a clear account of the closer dependence of Australian universities upon the State and Federal Governments, and this paper will assist those in Britain to understand some of the difficulties and dangers to which the Australian universities are exposed and also some episodes that may have puzzled those reading about them. Moreover, some of these dangers, such as that arising from the tendency in the thinking of Governments to subordinate research, advanced scholarship and post-graduate studies to the more elementary functions of making it possible for large numbers to gain degrees, could arise in Britain in appropriate circumstances; and Prof. Partridge notes other factors, such as the absence of any considerable proportion of university-educated men among Australian politicians, which have contributed to lack of understanding of the universities or respect for their autonomy in Australia. While he thinks the existing structure may be unhealthy and dangerous, he does not think that the independence of the Australian universities has been affected as much as might have been expected.

* Australian Vice-Chancellors' Committee. A Symposium on the Place of the Australian University in the Community and Post-Graduate Studies in the Australian Universities. Pp. 66. (Canberra: Australian Vice-Chancellors' Committee, c/o Australian National Committee. London: Association of Universities of the British Commonwealth, n.d.)

Prof. Partridge, moreover, offers some wise counsel to the universities which has relevance even in the more favourable circumstances of Britain. He suggests that, in spite of obvious dangers and difficulties, the universities should, in partnership with the Commonwealth and State Governments, attempt to evolve national policies of expansion and policies which will provide for some measure of specialization in the different universities, particularly in research. It is not unreasonable, he argues, to expect that the universities should at least explore the possibility of using as rationally as possible the greater resources placed at their disposal by the State, and there is much to be gained from the point of view of academic standards by not dispersing available workers too thinly over a comparatively large number of institutions. To take the initiative in such ways would, he believes, strengthen the universities themselves and might also facilitate the change in thinking of the State Governments which he also thinks desirable for the use of Commonwealth funds and to meet national needs. What Prof. Partridge urges has some relevance to the expansion of technological education in Britain.

The paper by Prof. D. M. Myers on the Australian universities and industry is essentially a factual account of these relations during the past hundred years, which emphasizes the factors dominating the present scene, such as the dependence of the Australian economy on its primary products, the extreme concentration of the population and of secondary industries in several major centres, and the unusual position in industrial research occupied by government institutions such as the Commonwealth Scientific and Industrial Research Organization. Prof. Myers comments on the unfavourable effect on the universities of this uneven distribution of the population, with the consequent tendency to parochialism and absence of interchange of staff, and he believes that it will be a happy day, too, for Australian industry when the universities regain a proper balance in their activities and are dependent on direct grants through an appropriate body set up for the purpose rather than on the support of a government body established for definite practical objectives. Prof. Myers makes some practical suggestions for future relations between Australian universities and industry on these lines.

Prof. A. Boyce Gibson's paper on the Australian universities and public opinion makes some sound points which should be noted in Britain, though he thinks that, in general, Australian universities have more to learn about public relations from the United States than from Britain. He suggests that the universities should do more to communicate their own scale of values and that the best way to open up public opinion is to do things the use of which is apparent to people uninterested in inquiry and scholarship: in science, by increasing welfare; in arts, by raising the standards of discussion and entertainment.

Prof. R. M. Crawford, discussing postgraduate studies in the non-science faculties, which he suggests are freer than the scientific and technical faculties from the restricting effects of the demand for highly trained professional artisans and research workers, does not believe that research and teaching staffs should be separated, but that more guidance could be offered at the undergraduate stage and that the quality of research rests fundamentally on the quality of the undergraduate schools. He stresses the importance of travel and of minimizing professorial administration. Dealing with postgraduate studies in science and engineering, Prof. L. H. Martin also deprecates the tendency in Australia to favour complete segregation of research from teaching and, in particular, to subjugate research and its proper function to the university's responsibility for postgraduate training. In the absence of a background of tradition, the Australian university, he urges, must foster close association with the community which supports it, and here the technological departments have a special responsibility. Prof. Martin is concerned that the average quality of science students has deteriorated in the post-war years. First-class talent is becoming rare among science graduates. There is evidence in Melbourne that the number of Ph.D. candidates in science is likely to decrease, and in 1954 there was only one applicant for the most prized travelling scholarship in science offered within member countries of the British Commonwealth. He also believes that lack of finance, including inadequate salaries, is the fundamental cause of frustration in Australian universities.

UNIVERSITY EDUCATION IN HUNGARY

At the eighth university conference organized by the International Association of University Professors and Lecturers and held in Vienna during September 9–14, 1954, Prof. L. Tamas, of the University of Budapest, described the development of university education in Hungary since 1945.

In recent years there has been a vigorous expansion in university education. In the year 1937–38 there were 12,000 students in the universities and the *grandes écoles* (13 per 10,000 population); in the year 1953–54 there were more than 53,000 such students (56 per 10,000 population). There were 473 foreign students in Hungary, and, with the exception of Australia, all quarters of the world were represented. In 1938–39 Hungary had 16 universities and *grandes écoles* with 37 faculties; to-day there are 33 universities and *grandes écoles* with 56 faculties. In 1952 and 1953 the State budget had given almost 260 million forints to the construction of new universities and the expansion of the older institutions.

Prof. Tamas also spoke of student conditions. In former years, the children of workmen and peasants, who formed the greater part of the country's population, represented 3½–4 per cent of the total number of students; to-day they constitute more than one-half of the total student body. Women students, to whom all careers are now open, represented 13 per cent of students in 1937–38. To-day the proportion is 26½ per cent. A noticeable change has taken place in the subjects read. Previously, more than one-half of university students and one-third of the total number of students followed courses in the faculty of law, while those who undertook technical and scientific studies formed much the smallest group. To-day this proportion is reversed: 47 per cent of the total number of students are registered in technical and science faculties, while 3 per cent only follow law courses.

A great deal of State assistance is given to university students. More than three-quarters pay no fees, the remainder pay minimum terminal charges. There are no charges for laboratory-work or examinations.

More than 90 per cent of the students benefit regularly from bursary grants, 17,000 reside in student hostels and 24,000 feed in student canteens. There is medical and social aid.

Prof. Tamas discussed curriculum reforms which have been introduced and brought closer in line with the country's economic and practical needs, and the extent of the advanced and research work undertaken in the Hungarian universities.

RED FOX IN THE UNITED STATES

AN evaluation of the red fox in the United States has been made by Thomas G. Scott, on behalf of the Illinois Natural History Survey*, which suggests that the fox has shown no sign of declining in numbers and that it has unusual capabilities for survival despite keen competition; the opening-up of forest lands and the reduction or elimination of wolves and coyotes seem to favour foxes. Some reports on rabies outbreaks in the eastern United States indicate that the fox is fully capable of reaching population-levels which are too high to serve its own interests.

The role of the red fox as a predator appears to be the most important of the various factors affecting the economic position of this animal. It tends to take the foods which are most readily available, and thus its diet varies immensely both with the season and the environment. The diet does not reflect precise, automatic adjustments to changes in population-levels of specific prey. For example, during the spring and summer, when prey such as rabbits, mice and birds are found in increasing numbers, the frequency of occurrence of these items in the fox's diet declines where acceptable fleshy fruits and insects are available. Thus it would be unwise to claim or expect an increase in numbers of prey species in response solely to the reduction or elimination of red foxes. A large-scale experiment with the reduction of a fox population as a means of increasing a pheasant population in New York State resulted in the conclusion that "despite reducing the fox population to a very low level, fox control on the Seneca County area did not increase pheasant abundance appreciably and certainly not to a degree commensurate with the cost". Though foxes unquestionably prey upon vulnerably situated poultry, and to a lesser extent on small pigs and lambs, it seems that poultry losses result largely from failure of owners to follow recommended poultry-husbandry practices.

Foxes are among the most important vectors of rabies in the United States, and herein probably lies their greatest nuisance. People living in an area where rabies has been reported experience great mental distress, and may even have to suffer the physical discomfort of Pasteur treatment if attacked. It is certain that losses occur among livestock infected through the bites of rabid foxes. When rabies breaks out in a locality of high fox population, the disease is likely to continue until the foxes in that general area are virtually exterminated; this may take from one to three years.

The most desirable method known for bringing rabies outbreaks among foxes under control has proved to be population reduction by means of organized trapping; but whether the several million dollars that has been paid out during the past twenty years on fox bounties has been money well spent is a question open to doubt. Experience in Pennsylvania indicates "that probably 50 per cent or more of the mammalian predators (red fox, gray fox, and weasel) would have been killed regardless of the bounty". The bounty system cannot be directed efficiently toward the reduction of specific, excessive fox populations because the administrative areas in which funds are approved for bounties seldom conform with the particular areas needing attention. The economic demand for red fox pelts is at present very low. The sport of fox-hunting contributes to the reduction of fox populations, and the survey, which is well illustrated, discusses the ethical and æsthetic values involved in this sport.

* Natural History Survey Division of the State of Illinois. Biological Notes No. 35: An Evaluation of the Red Fox. By Thomas G. Scott. Pp. 16. (Urbana, Ill.: Department of Registration and Education, 1955.)

STIMULATION OF YIELD FROM RUBBER TREES

A GOOD deal of work has been done at the Rubber Research Institute of Malaya, both before the Second World War and, more recently, on the stimulation of yield in the rubber tree *Hevea brasiliensis* by applications of vegetable oils (for example, palm oil) and various synthetic substances, and several aspects of this are described by E. D. C. Baptist and P. de Jonge in the *Journal* of the Institute (**14**, 355; 1955). A brief historical review is given of methods used for stimulating the latex yield of rubber trees, and experiments are described in which vegetable oils applied to lightly scraped bark below the tapping-cut resulted in large increases in yield.

The results of these early experiments provided a clear picture of the reaction of the tree to yield stimulation and led to the development and commercial use of yield stimulants. Similar application of a number of synthetic growth substances in an oil vehicle has also resulted in increases in yield and in the thickness of renewed bark above the cut. Repeated applications of the treatments at six-monthly intervals over a period of three years have not resulted in an increased incidence of 'dry' trees; but the yield response is found to decrease with each successive treatment. Monthly treatment with yield stimulants of renewing bark just above the tapping-cut has also resulted in greatly increased yields and in an increase in bark thickness; the latter is confined to the non-latex-bearing tissues of the outer bark. A study has been made of the effects of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) on the rubber extraction area of the bark on tapping, the incidence of brown bast, rate and duration of latex flow, anatomical structure of the bark, and the properties of latex and dry rubber.

The response of the rubber tree to yield stimulants is shown to be influenced by the condition of the bark, the type of planting material, the tapping system, the composition and method of application of the mixture. An extension of the area of rubber extraction in the bark of trees in normal tapping as a result of treatment with yield stimulant has been demonstrated experimentally and is thought to account for the increased yields obtained and for the low incidence of brown bast after repeated treat-

ment. The increase in bark thickness observed is caused by induced meristematic activity in the cortical and phloem regions, resulting in prolific development of undifferentiated parenchyma tissue, and not by activation of the vascular cambium. The rate and duration of latex flow are increased after treatment with a yield stimulant, and there is a slight decrease in the dry rubber content of the latex which usually reaches its lowest value in the second month following treatment.

PROPHYLACTIC ACTIVITY OF SURAMIN COMPLEXES IN ANIMAL TRYPANOSOMIASIS

By Dr. J. WILLIAMSON and Dr. R. S. DESOWITZ

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THE first, and still the most effective, prophylactic drug for bovine trypanosomiasis is 'Antrycide Pro-Salt' (a mixture of antrycide dimethylsulphate and antrycide chloride)[1,2]. Experience has shown that the maximum reliable prophylaxis obtainable with this drug is approximately two months[1-3]. The administrative work, however, required to locate and inject nomadic cattle six times a year at two-monthly intervals is usually too great to be practicable.

Some preliminary results of an investigation designed to extend the existing period of prophylaxis, using trypanocidal drugs in common use, are described here.

The possibilities of using a suramin–pentamidine salt complex to extend the pentamidine prophylaxis of human trypanosomiasis were indicated by Guimaraes and Lourie[4]. On the basis of an observation made by Lourie during a sleeping sickness campaign in 1939–41[5], these authors showed that suramin could inhibit many of the pharmacological or toxic effects of pentamidine, primarily by the formation of an inactive salt complex. Experimental confirmation of extended pentamidine prophylaxis in rats by this method has been reported by Schneider (see ref. 8), and by Cosar, Ducrot, Gailliot and Baget[6]; Beaudiment and Zozol[7] and Beaudiment, Cauvin and Leproux[8] have further shown that suramin can reduce the toxicity of pentamidine in man.

It seemed probable that suramin might form similar salt complexes with drugs active in bovine trypanosomiasis, which are all strongly basic compounds like pentamidine. Suramin was, in fact, found to form insoluble precipitates *in vitro* with solutions of ethidium and dimidium bromides, the *bis*-cinnolinium compound '528'[9], antrycide dimethylsulphate, and a new German diamidine-type trypanocide 'Berenil' (di-(amidinophenyl)-triazene (-N-1:3) diaceturate)[10].

As ethidium bromide is the most active member of this group, prophylactic experiments in rats and mice were begun, using combined treatment with suramin and ethidium bromide. At this time, Dr. W. E. Ormerod kindly made available to us the results of his experiments on the suramin detoxication of antrycide dimethylsulphate[11], following an analogy between the pharmacological effects of antrycide and curare; the toxicity of the latter was known to be reduced by prior administration of acid dyes such as congo red[12], which is related to suramin.

Although initial experiments showed that some degree of prophylactic activity was being conferred on ethidium bromide by suramin administration, the toxicity of the former drug was not markedly reduced by simultaneous or prior treatment with a separate injection of suramin under widely varied conditions. The quantitative basis of complex formation was therefore examined, since, theoretically, one molecule of suramin, with six sulphonic acid groups, could combine maximally with six molecules of ethidium or dimidium bromide, or with three molecules of antrycide, '528', 'Berenil' or pentamidine. Gravimetric analysis showed that the combining proportions did in fact approximate closely to the theoretical, and suspensions of the precipitated complexes prepared by mixing aqueous neutral solutions of the drugs according to these proportions were afterwards given throughout as a single injection.

Results in rats given a single subcutaneous maximum tolerated dose of the suramin complex of ethidium, dimidium, antrycide, '528', and 'Berenil', showed that there was a maximum decrease in the toxicity of these drugs of approximately 10-, 5-, 14-, 8- and 3-fold, respectively. Prophylactic experiments in rats and mice repeatedly infected intraperitoneally with a virulent strain of *Trypanosoma congolense* showed that suramin-complex formation induced or increased prophylactic activity in all the drugs tested, but to a varying degree. In the case of dimidium, ethidium, and '528' the increase was only of the order of a week or two; with 'Berenil' the increase was approximately five to seven weeks, and with antrycide dimethylsulphate, more than fifteen weeks.

Suramin complexes of three trypanocidal compounds have been tested in cattle for prophylactic activity; these were antrycide dimethylsulphate–suramin, ethidium bromide–suramin and 'Berenil'–suramin. Since the 'Berenil'–suramin complex showed little prophylactic activity even at a dosage of 40 mgm./kgm., it will not be discussed in this communication. (Dosages throughout refer to the amount of the basic drug present in the complex, and *not* to the total amount of the complex.)

The trials were carried out at the Institute's laboratories at Vom, which is in a tsetse-free area. The animals used were zebu cattle and each was given a *single* injection of drug-complex or, in the case of controls, the drug alone. The animals were then challenged repeatedly with cyclically transmitted trypanosomes. This challenge was delivered by *Glossina palpalis* reared in the laboratory, which had first been given multiple feeds on an ox or sheep heavily infected with *Trypanosoma vivax*; subsequent sample dissections showed that 90 per cent or more of the flies in each batch were infected. Batches of 100–150 infected flies were fed on each experimental animal for three consecutive days, and this challenge was repeated every ten to fourteen days until break-

Table 1. PROPHYLACTIC ACTIVITY OF SURAMIN COMPLEXES IN ZEBU CATTLE

Drug	Dose*	No. zebu used	Prophylaxis afforded (days)
Antrycide dimethylsulphate (control)	5 mgm./kgm.	3	39, 41, 52
Antrycide pro-salt (control)	5 mgm./kgm.	5	69, 72, 75, 80, 91
Antrycide dimethylsulphate – suramin complex	10 mgm./kgm.	5	95, 95, 115, 120, 129
	20 mgm./kgm.	5	135, 146, 149; 2 animals still not infected at 196 days
	40 mgm./kgm.	5	162, 163, 179; 2 animals still not infected at 196 days
Ethidium bromide (control)	5 mgm./kgm.	4	57, 102, 122, 147
Ethidium bromide – suramin complex	5 mgm./kgm.	2	216; one animal still not infected at 217 days
	10 mgm./kgm.	3	None infected to date (217 days)

* Dosage of complexes refer to amounts of antrycide dimethylsulphate or ethidium present in complex form.

through occurred. Four strains of *T. vivax* were used in this manner. The zebus were also challenged with wild *G. longipalpis* from Southern Nigeria which were infected with both *T. vivax* and *T. congolense*.

The results of these trials are summarized in Table 1. No toxic symptoms were noted at any dosages of complexes given. There was the usual swelling due to the depot of drug, but the surrounding area did not become inflamed or œdematous. It will be seen that considerably more drug in complex form can be given safely than the known maximum safe doses of the drug alone. This is especially true for antrycide dimethylsulphate, where the maximum tolerated dose of the drug alone is 5 mgm./kgm., but in complex form the maximum tolerated dose is 40 mgm./kgm. Detoxication is less marked in the case of the ethidium–suramin complex, where 10 mgm./kgm. appears to be the maximum tolerated dose. This is compensated for, however, by the marked prolongation of prophylactic activity of ethidium complex at low dosage. Reference to Table 1 shows that in the case of the antrycide dimethylsulphate complex the ability to give more drug safely results in a markedly increased prophylactic period; at the highest dose used (40 mgm./kgm.), at least five and a half months protection can be relied upon.

Although the number of animals used for the ethidium-complex trial is small, there is every indication that this complex is the most promising. This is of interest since the prophylactic trials in small animals gave little indication of its activity in cattle. Seven months protection has been afforded by as little as 5 mgm./kgm. of complex, and at 10 mgm./kgm. no break-through has yet taken place after 217 days. A larger trial with the ethidium-complex is planned. A full account of these trials will be published elsewhere.

We are indebted to Dr. T. A. M. Nash, director of this Institute, for his continued interest and encouragement of this work. [March 28

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DIAMOND AS A PINPOINT RADIATION COUNTER*

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SINCE van Heerden (1945) reported that silver chloride, at low temperature, would detect β-particles, several other crystals have been found which possess this property. In this work I am concerned with only one of them, namely, diamond, a room-temperature counter discovered by Wooldridge, Ahearn and Burton[1]. A crystal with this advantage makes the design of a practical crystal counter much simpler, and my work has been chiefly concerned with investigating the possibilities the diamond may have of eventually being developed into a useful pinpoint counter.

Besides its ability to count efficiently, the diamond has physical and chemical properties which make it an attractive material for use in a practical counter. If the counter were intended primarily for medical use, these properties would have added significance, especially the density of the crystal. Physically, its density is such that diamond has a stopping power nearly three thousand times greater than that of air, and electronically, the density (and the γ-ray absorption) of carbon is of the same order as that of human tissue. Thus a high-speed particle would penetrate both diamond and tissue to about the same degree. Consequently, if the diamond counter were to be used to measure the dose-rate on patients receiving deep therapy or similar treatment, one would expect to get more accurate measurements than could be obtained with more conventional instruments. Furthermore, because of its chemical composition, diamond can be autoclaved and sterilized satisfactorily for use internally.

The advantages of the diamond as a counting crystal have been recorded elsewhere[2]. In contrast to its many desirable features looms the bugbear of polarization, due to the space charge which builds up inside a counting crystal and opposes the externally applied field, thus causing considerable reduction in the counting efficiency of the crystal. It is caused by the current carriers being captured by the trapping sites in the crystal. Since every diamond reacts differently, it was just possible that diamonds did exist which were electronically perfect enough not to be seriously affected by polarization. I therefore

* Substance of a thesis which was awarded the Insignia Award of the City and Guilds of London Institute in 1955.

sorted through approximately a hundred thousand diamonds to test this possibility, and I am convinced that such diamonds occur in Nature. These diamonds make really efficient counters and will maintain a reasonably steady counting-rate for periods of several hours, perhaps indefinitely. For this test I used a 1-mc. γ-source (cobalt-60) placed at a distance of 1 cm. from the diamond. Such diamonds have been used for the past five years, and I classify them as structure-sensitive diamonds peculiar to certain diamond fields. Using small octahedra of 1 mm. side, Champion (unpublished work) has shown that the non-polarizing regions of a counting diamond fall into class 2 of his identification table for diamonds. My specimens, on the other hand, have varied widely in size and shape, and for sorting purposes I have had to rely on the ultra-violet fluorescence method for selecting counters.

Ahearn has shown that under the influence of rays from a radioactive source a counting diamond, working in an electric field, will generate small pulses of current. Under these conditions, an electron and a positive hole will be created every time a high-speed particle communicates sufficient energy to a carbon atom. This is analogous to ionization in a gas. In a diamond, relatively free of electron traps, the electrons and the positive holes move in opposite directions with substantially the same velocity and, by placing the diamond in a suitably designed electronic circuit, the movement of the current carriers can be measured.

In the early laboratory experiments the diamond was placed as close to the grid of the pre-amplifying valve as possible, since the signal voltage is inversely proportional to the capacity of the circuit. For practical purposes, however, it is necessary to move the diamond some distance away from the pre-amplifier. This entails two alterations to the conventional circuit: (i) slight modifications to the electronic circuits, and (ii) a properly designed diamond holder. After some preliminary experiments, I found that the diamond may be conveniently mounted at the end of a thin, hollow metal tube or a flexible coaxial cable to form a probe. The length of the probe is limited by the amount of capacity permitted in the circuit, but probes up to a foot in length have been made and function satisfactorily. In one instance the external diameter of the probe was less than 3 mm. and, in this case, the volume of the diamond was probably no more than two or three cubic millimetres. For best results the diamond should be cut to fit snugly into the end of the tube. My method of mounting the diamond in such a tiny holder is to have a hole drilled in the diamond just large enough to accommodate a very thin wire. This wire acts as an anode and runs down the middle of the tube. It is insulated from the outer metal holder, which is at earth potential. The potential difference between the inner electrode and the holder creates the energizing field for the diamond.

The pulses generated by the diamond under bombardment are of the order of microvolts and have to be amplified considerably before they will operate conventional recording devices. A linear amplifier is employed for this purpose. One of the limitations of this type of amplifier is the noise which is generated by the pre-amplifying valve and its associated circuits. This noise sets a threshold limit to the sensitivity of the diamond counter at approximately 25 μV. This in turn determines the lowest energy which can be recorded by a diamond counter under present conditions; but for α- and β-sources usually used in the laboratory the diamond counter is as efficient a counter as the Geiger counter[3].

To date, work on the diamond counter has been confined to a limited number of research workers whose preliminary investigations have demonstrated some of its advantages and disadvantages. The indications are, however, that it has possibilities of ultimately being developed into a useful pinpoint counter suitable for specialized—probably medical—applications. The potentialities of the diamond in this field therefore merit fuller investigation.

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ANTARCTIC ATMOSPHERIC CIRCULATION

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IN 1951[1] I put forward the view that general attempts to interpret Antarctic atmospheric circulation in terms of a permanent low-level anticyclone surmounted by a permanent upper cyclone could not be reconciled with the sequences of daily synoptic weather maps of the southern hemisphere, which were then becoming available for the first time. In particular, the concept of permanency was untenable, as in the case of atmospheric circulation systems in other parts of the world.

The problems raised by (1) continuing nourishment (at least, in some degree) of the Antarctic ice-cap and (2) occasional observations of cyclonic winds and weather on the coast and by expedition parties in the interior of Antarctica could only be resolved in terms of a succession of changing weather situations. Evidence now exists that these situations embrace *inter alia* both (warm) anticyclones and (cold) depressions in which the respective circulation systems reach to great heights without change of character[2,3].

It will be generally accepted that katabatic downslope surface winds are predominant at most points of the fringe of the ice-cap and, to a less extent, probably on the higher parts of the inland ice. It has also become clear that most of the active depressions which skirt, or encroach upon, Antarctica have closed cyclonic circulations extending at least up to the higher parts of the ice-cap, which are liable to be swept by gales and experience the frontal clouds and weather.

In collaboration with Instr. Commdr. G. P. Britton, R.N., I have lately confirmed and amplified these conclusions by making statistical studies of (*a*) the distribution of centres of depressions and anticyclones in high southern latitudes on the daily weather charts[4] analysed during 1947–49 by Britton and Morgan at the Royal Naval Investigational

Weather Centre at Simonstown, South Africa, and (*b*) the percentage frequency of occurrence of surface westerly winds in all sectors of the coast of Antarctica and near the ice-edge at sea south of 60° S. Some of these results have already been published[5].

The geographical distribution of anticyclone centres over the southern polar regions, derived from the Simonstown daily synoptic analyses of the southern hemisphere, on 134 days when such deduction was possible during January–April and November 1947 and March–April 1948, showed the main concentration of anticyclones displaced from the geographical pole in the direction of the broadest part of Antarctica, perhaps as far north as lat. 85° S. in long. 40–50° E. This position is very close to the true centre of the ice-covered polar region, but may reflect an unconscious bias on the part of those analysing the daily charts to indicate the anticyclone as near to the South Pole as could be made to fit the evidence. It is also in reasonable agreement with the main cluster of centres of highest monthly mean pressure about lat. 82° S., long. 60° E. in the three years 1951–53 given by the Southern Hemisphere Daily Weather Analysis Project of the South African Weather Bureau, Pretoria[6]. There is perhaps some ground for preferring to believe the more eccentric position.

Careful assessment of all these data and re-examination of the weather logs of the main expedition journeys of the past into the interior of Antarctica have made possible a reasonable estimate of the frequency of generally cyclonic weather situations over Antarctica (largely resulting from the encroachment of large travelling depressions from other latitudes) and has yielded unmistakable evidence of individual deep depressions as they passed inland over the ice.

The frequency of cyclonic situations in the interior, with westerly winds at the coast, may be given as about 5–15 per cent for different parts of the continent, though there are great variations from year to year. In some particular months (for example, March 1947) the percentage may have been 50 per cent or even higher. East Antarctica between lat. 0° and 90° E. is probably most nearly immune. Surprisingly, cyclonic situations and low pressures are more frequent in winter than in summer (with a possible reservation in the case of the Graham Land–Weddell Sea sector, where pressures tend to be relatively high both in December–January (summer) and in May–July (early winter)).

The majority situations (85–95 per cent) are quite various, though there is usually either a shallow surface anticyclone or a region of relatively high surface pressure and slack circulation somewhere over Antarctica, especially "East Antarctica" (where the continent is broadest), between the surrounding depressions. The central anticyclonic region, even when it is most clearly defined, sometimes takes up a position far out from the Pole in one sector or another for fairly long periods, and may at times be centred over the ice of either the Weddell or Ross Seas: disturbed conditions then usually prevail in the opposite sector.

Several cases are on record in which very deep depressions (mean sea-level pressures 927–945 mb. at the nearest coastal bases) passed inland south of the Adélie Land coast (lat. 67° S., long. 140–145° E.) and Ross Barrier (lat. 78° S., long. 160–180° W.), in all cases between late June and early October. At least two of these depressions passed south of Admiral Byrd's 1934 advanced base (Bolling Station) in lat. 80° S. on the Ross Barrier.

The occasional southerly gales experienced even in summer by all parties on the polar plateau between the Ross Sea and the South Pole would be consistent with depressions passing on a track near lat. 80° S. from the Ross to the Weddell or Bellingshausen Seas—the shortest track across West Antarctica. These gales blew up the general gradient of the ice plateau (that is, against the katabatic effect) between 88° S. and the Pole.

Independent summaries dealing with antarctic meteorology[3,7] suggest that there is now a good consensus of opinion among workers in various countries in support of my main thesis regarding impermanence of the antarctic anticyclones and great variability of the general weather situation, especially in winter.

The geographical distribution of the antarctic anticyclones, which is now becoming clear, has a corollary of some possible practical importance: the frequency of the gales which sweep the polar plateau should fall off from the Pole in the sector of East Antarctica, so that the "fairest weather route to the pole" (the phrase is Britton's) may be expected to lie across that part of the continent between about the 0° and 90° E. meridians. This appears to be the preferred region for anticyclones and is relatively infrequently encroached upon by depressions. Moreover, in longitudes between 20° W. and 20° E., east of the Weddell Sea, the general circulation around these anticyclones (which are the heavily predominant situation in summer, that is, December–January) should tend to oppose and offset the general katabatic drainage of cold air off the ice-cap, which blows in the face of expedition parties on the ground making for the polar plateau. This suggests that, on the whole, there should be relatively least trouble with headwinds, blizzards and snow in longitudes between about 20° W. and 45° E., whatever the geographical difficulties of the route might be. At the same time, expeditions must always reckon with the characteristic type of variability (most pronounced between March and October) of the Antarctic atmospheric circulation, which is liable to long spells, lasting in extreme cases up to two to three months, of unusual circulation patterns when any part of the interior may be liable to experience cyclonic weather.

The same work on the meteorology of the far south led to certain hypotheses about major geographical features—a great trough and a great ridge—in the broadest, unexplored region of the Antarctic continent in eastern longitudes. One of these hypotheses has recently been confirmed by observation (*The Times*, March 7, 1956).

I am indebted to the Director of the Meteorological Office for permission to publish this account.

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LETTERS TO THE EDITORS

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Isolation of Two Myoglobins from Horse-heart Extracts and the Determination of the Molecular Weight of the Main Component

THE method developed by Boardman and Partridge[1] for the separation of hæmoglobins on columns of the ion-exchange resin, 'Amberlite *IRC*-50' (*XE*–64), has been applied to the purification of horse carbon monoxide myoglobin, with the result that two carbon monoxide myoglobins were isolated from extracts of horse heart. The component carbon monoxide myoglobin (*B*) was present to the extent of about 10 per cent of the main myoglobin fraction, carbon monoxide myoglobin (*A*). Each fraction was shown to be homogeneous in the ultracentrifuge, and when examined in a Hilger 'Uvispek' spectrophotometer each gave an absorption spectrum typical of carbon monoxide myoglobin. The molecular weight of the main component was determined from measurements of osmotic pressure[2] and a detailed amino-acid analysis was carried out by the procedure of Moore and Stein[3].

A water extract from a perfused horse heart was saturated with carbon monoxide, and an ammonium sulphate fractionation of the proteins was carried out at 0° C. Most of the colourless muscle proteins and residual carboxy hæmoglobin were precipitated at 80 per cent saturation, and the carbon monoxide myoglobins were precipitated by raising the concentration of ammonium sulphate in the filtrate to 94 per cent saturation. The carbon monoxide myoglobins were dissolved with the minimum amount of distilled water and then dialysed against a citrate buffer, *p*H 5·70; sodium ion concentration, 0·34 gm. ions/l. An aliquot (20 ml.) of the myoglobin solution was subjected to chromatography on a column of 'Amberlite *IRC*-50', 16·5 cm. × 5·0 cm., with the citrate buffer as eluting liquid. The effluent from the column was collected in 3-ml. fractions and analysed photometrically at 278μ and 542μ. The result is shown in Fig. 1. The first band of protein to emerge from the column contained colourless proteins which had not been removed by the ammonium sulphate fractionation. This was followed by a band of hæmoprotein carbon monoxide myoglobin (*B*), which was almost completely separated from the main band of hæmoprotein carbon monoxide myoglobin (*A*). The main-fraction carbon monoxide myoglobin (*A*) behaved as a single substance when applied to a fresh column of the same resin and could be eluted from it quantitatively.

Table 1

Conc. of protein (gm./100 ml.)	Osmotic pressure (mm. mercury at 0° C.)	M/φ*	Molecular wt. (*M*)
0·43	3·99	18,326	18,551
0·51	4·72	18,548	18,822
0·64	5·93	18,228	18,563
1·01	9·54	18,029	18,559
1·46	14·20	17,464	18,211
1·51	14·72	17,415	18,188
		Average	18,482

* φ is a factor taken from measurements on hæmoglobin (ref. 4). External liquid, 0·03 *M* Na_2HPO_4 + 0·01 *M* NaH_2PO_4. *p*H 7·4 at 0° C.

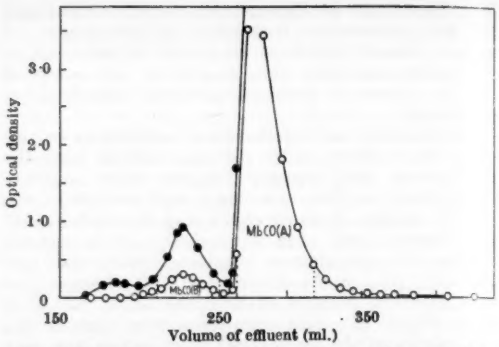

Fig. 1. Chromatogram of a preparation of horse carbon monoxide myoglobin on a column of 'Amberlite *IRC*-50', 16·5 cm. × 5·0 cm. Buffer citrate, *p*H 5·70, sodium ion concentration 0·34 gm. ions/l. Rate of flow: 5–10 ml./hr. Temp. 2° C. Amount on column: about 300 mgm. protein. ○, Optical density at 542μ; ●, optical density at 275μ

The dotted lines in Fig. 1 indicate the fractions collected as carbon monoxide myoglobin (*A*) and carbon monoxide myoglobin (*B*). The absorption spectra of the two proteins were identical in the visible and Soret regions; but the latter showed a higher absorption at 275μ, indicating a higher tyrosine or tryptophan content. Examination in the 'Spinco' ultracentrifuge showed that both preparations were homogeneous and they had similar sedimentation constants.

The molecular weight of the main-fraction carbon monoxide myoglobin (*A*) was determined from measurements of osmotic pressure, using the toluene osmometers of Adair[4]. Membranes which held about 1·5 ml. protein solution were used, special care being taken to make thin membranes which did not adsorb myoglobin. Concentrations of protein were calculated from refractometric measurements; but in certain cases these were checked by making cyanmetmyoglobin and measuring its absorption at 542μ. The extinction coefficient of a solution containing 1 mgm./ml. of cyanmetmyoglobin (*E* 0·1 per cent) was found to be 0·613.

The results of the osmotic pressure measurements are shown in Table 1. The figure obtained for the mean molecular weight of the main component was 18,400, which is considerably higher than the 16,800 obtained by Roche and Vieil[5] from osmotic pressure measurements and 17,200 obtained in ultracentrifuge studies[6].

Table 2. AMINO-ACID COMPOSITION OF CARBON MONOXIDE MYOGLOBIN (*A*) (TOTAL NITROGEN 17·0 PER CENT)

Amino-acid	Wt. amino-acid in 100 gm. protein	No. residues/molecule	
		Present work	Tristram (ref. 7)
Glycine	6·68	15	13
Alanine	7·90	15	15
Valine	4·68	7	6
Leucine	13·33	17	22
*iso*Leucine	6·56	9	
Phenylalanine	7·04	7	5
Tyrosine	2·33	2	2
Threonine	4·73	7	7
Serine	3·09	5	6
Methionine	1·75	2	2
Proline	3·12	5	5
Aspartic acid	7·81	10	10
Glutamic acid	16·70	19	19
Arginine	2·14	2	2
Lysine	15·29	18	18
Histidine	9·00	10	9
Tryptophan	—	(2)	2
Total	112·15	152	143

Moreover, the number of amino-acid residues per molecule calculated from the present amino-acid analysis (Table 2) is greater than the number calculated by Tristram[7]. The present figures were obtained from 24-hr. and 96-hr. hydrolysates (6 *N* hydrochloric acid under reflux) and corrections were made for the decomposition of certain amino-acids. When compared with Tristram's figures, it is seen that there is an increase in the number of residues of leucine – *iso*leucine (4), phenylalanine (2), glycine (2), valine (1) and histidine (1) and a decrease of one residue of serine.

A full account of these experiments will be published later.

While this work was in progress, Theorell and Åkeson[8] recorded an electrophoretic diagram for myoglobin showing three components. The main component, Mb 1, had an equivalent weight of 18,800, calculated from iron analyses, nearly equal to the molecular weight of our fraction MbCO*A*.

We thank Dr. D. A. Titchen for perfusion of horse hearts. The amino-acid analysis was carried out by Mr. D. F. Elsden. This work, which forms part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research, was carried out during the tenure by one of us (N. K. B.) of an I.C.I. fellowship.

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An Extrarenal Effect of Pitressin

It is generally believed that the action of pitressin, and more specifically, antidiuretic hormone, is entirely referable to its effects on the kidney. Although an extrarenal site of action has been suggested, the evidence has not been convincing[1]. Our recent studies in the rat suggested that pitressin might have an extrarenal action in this mammal[2]. This would agree with the findings in other vertebrate classes[3].

The problem was studied in the rat using inulin, as modified from the method of Ledingham[4], to measure extracellular fluid volume. The renal pedicles were first ligated. One hour later, a measured amount of inulin was injected into the right femoral vein and two hours allowed for equilibration. At this time (0 min.), using light ether anæsthesia, a 0·5-ml. sample of blood was obtained from the left femoral artery and analysed for inulin and sodium. This was followed immediately by the injection of 1 I.U. of pitressin (Parke, Davis) in 0·5 ml. of saline intraperitoneally in a group of ten animals. A control group of ten received the saline only. A second blood sample was obtained 40 min. later from the same artery. The procedure was repeated in fresh groups to cover intervals of 60, 90 and 120 min. after injection of pitressin.

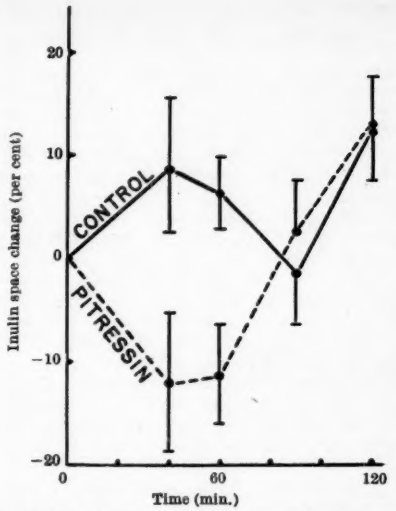

Fig. 1. Effect of 1 I.U. of pitressin intraperitoneally on inulin space in nephrectomized rats. Time of injection of pitressin is taken as 0, inulin having been injected 2 hr. previously to allow for equilibration

As shown in Fig. 1, pitressin caused a significant decrease in inulin space which can only signify a movement of water into the intracellular compartment. This was apparently accompanied isosmotically by sodium, since the plasma concentration of this ion remained unchanged throughout despite the decline in inulin space. In Table 1 the change in inulin space in two separate experiments is shown for the period of 60 min. after injection of pitressin.

Table 1. Effect of 1 I.U. of Pitressin on Inulin Space in Nephrectomized Rats

The first space determination, at 0 min., was carried out 2 hr. after inulin injection and was followed immediately by the injection of pitressin in the treated animals and saline in the control animals

	0 min.	60 min.	Change (per cent)	
Experiment 1				
Control average	26·64 ml.	27·86 ml.	+6·46	
Standard error	±1·93	±1·67	±3·51	
Pitressin average	26·63	23·59	−11·05	$p < 0·01$
Standard error	±1·37	±1·71	±5·02	
Experiment 2				
Control average	23·66 ml.	22·33 ml.	−5·53	
Standard error	±0·75	±0·93	±2·70	
Pitressin average	23·21	19·48	−15·95	$p < 0·02$
Standard error	±0·98	±1·12	±3·51	

The details of this shift as studied using smaller doses of pitressin intravenously, together with the effects of sodium and potassium, will be reported separately.

We are grateful to the Ciba Company, Ltd. (Montreal), for support of this project.

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Secretory Potentials and Secretion in the Sublingual Gland of the Cat

Intracellular recording from sublingual gland cells in cats has revealed that the resting potential over the outer membrane is about 30 mV. (internal negativity). On repetitive stimulation of the chorda nerve, the potential difference increases to 50–60 mV., and this potential change is called a secretory potential[1].

When the tip of the electrode is inserted further through the gland cell, the tip penetrates the inner gland-cell membrane, and the resting potential of the lumen is found to be a few millivolts positive to the external medium. On activation, the initial potential change in the lumen is identical with the potential change in the interior of the gland cell. Thus the initial potential change is entirely over the outer cell membrane of the gland. With continued stimulation of the chorda nerve, a potential change usually, but not always, appears also over the inner membrane, its sign showing that the lumen becomes more positive to the interior of the gland cell.

For investigation of the mechanism of establishment of the secretory potential over the outer membrane, the secretory potential was investigated at different levels of membrane potential. For this purpose double-barrelled electrodes were used. After insertion through the outer membrane of the gland cell, the potential was measured with one channel and current flowed through the other. Fig. 1 shows that the secretory potential appears almost unchanged within a large range of membrane potential. Thus the secretory potential has no equilibrium potential. Hence it cannot be due mainly to a change in permeability but must be due to active transport. It is assumed that this transport is in the same direction as the secretory work, and to account for the sign of the potential it must be a transport of anions from the external medium to the interior of the gland cell over the outer membrane.

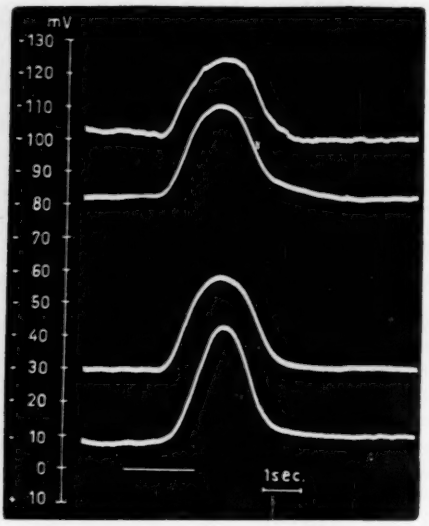

Fig. 1. Intracellular recording from sublingual gland cell with one channel of a double-barrelled electrode. Duration of repetitive stimulation of the chorda nerve at 25/sec. shown by white line. Record with a resting potential of 30 mV. was obtained without current flow through the other channel, and the remaining records with a current flow to change the 'resting' potential as seen in the figure (potential due to common coupling resistance subtracted)

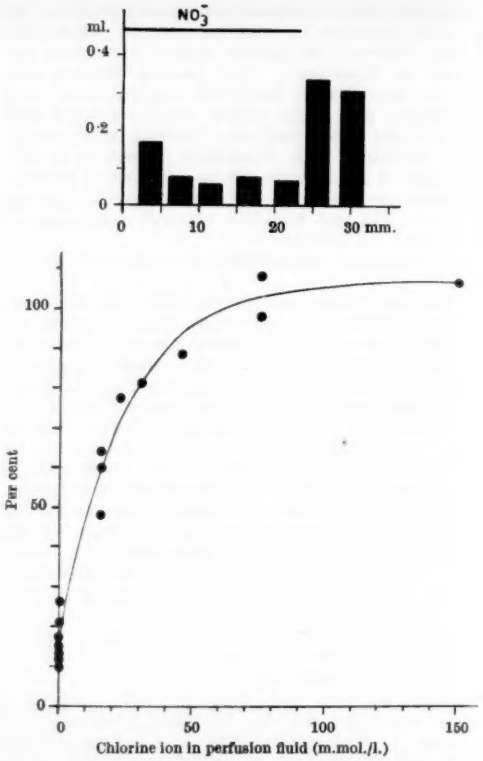

Fig. 2. In the upper plot each black column represents the amount of saliva obtained during 3 min. after injection of 1 μgm. acetylcholine. Horizontal black line shows duration of perfusion with chloride-free nitrate-saline; after 23 min., replacement with saline containing 150 m.mol./l. chloride. The graph shows the amount of secretion in response to 1 μgm. acetylcholine with partial substitution of chloride by nitrate in perfusion fluid. Ordinates, amount of secretion as percentage of that obtained in the same gland after change to a perfusion fluid containing 150 m.mol./l. chloride

This active transport of anions could account for secretion of salt and water; cations could follow due to electrical forces and water osmotically, and for passage through the inner membrane of the gland cell into the lumen of the tubulus the raised intracellular hydrostatic pressure might suffice. The sublingual gland saliva contains 160 m.mol./lit. chloride ion, and these ions are those that are transported if the secretory potential be the electrical sign of a transport responsible for secretion of salt and water. An active transport of chloride ions has been found in frog skin stimulated by adrenaline[2] and also in the frog gastric mucosa[3].

Further experiments have been made with glands perfused with oxygenated saline (at room temperature) containing physiological concentrations of sodium, potassium and calcium ions and with chloride as the only anion. On activation, such a gland gives a normal amount of secretion and the secretory potential over the outer membrane appears as in the blood-perfused gland.

On replacement of chloride ion in the perfusion fluid with nitrate ion the amount of secretion obtained on injection of 1 μgm. acetylcholine falls to 10–30 per

cent (Fig. 2). The graph in Fig. 2 shows the amount of secretion in response to 1 μgm. acetylcholine with partial substitution of chloride by nitrate in the perfusion fluid. The amount is given as a percentage of the amount of saliva obtained in the same gland after return to a perfusion fluid with full chloride content. It appears that with 10 per cent chloride the gland secretes 50–60 per cent of the normal amount, and with 50 per cent chloride the secretory response is virtually the same as with 100 per cent chloride. These experiments show that nitrate ions are not toxic to the secretory process; the limiting factor for secretion at low chloride concentration is most probably depletion of chloride ions in the external medium of the gland cells (the amount of secretion in response to 1 μgm. acetylcholine at 100 per cent chloride ions is about one-fourth of the weight of the gland).

In experiments with microelectrodes on the nitrate-perfused gland, a small potential change with the same sign as the normal secretory potential was encountered over the outer membrane on activation. It is therefore possible that this membrane has a limited capacity to transport nitrate ions, which transport may account for the secretion remaining in the nitrate-perfused gland.

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Changes in the Dimensions of the Nuclei of Neurones with Activity

HYDEN[1] has summarized the evidence relating changes in cytoplasmic and nuclear constituents of the neurone to growth and activity of the cell. We have found an increase in Feulgen staining in the neurone nuclei of both the granular and molecular layers of the mouse cerebellum, following convulsions produced by 'Picrotoxin' and 'Metrazol', as well as after a fall[2]. The deoxyribonucleic acid content, measured by the specific absorptiometric technique[3], however, remained unchanged following a 'Picrotoxin' convulsion. These two findings suggested that an explanation of the apparent increase in Feulgen staining might be found in a contraction of the nuclei.

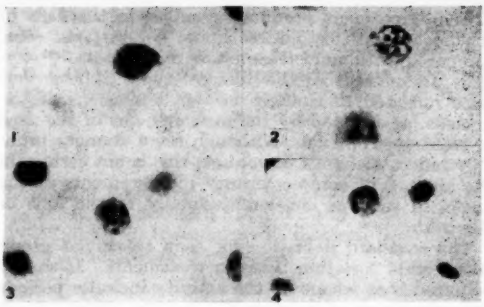

Fig. 1. Nuclei from the molecular layer of mouse cerebellum. (1) Resting mouse. (2) After running to exhaustion, 200 ft. in 10 min. (3) Convulsed with 'Picrotoxin', C.D.50. (4) Following a fall, 3 × 10 ft.

A change in dimensions of the nuclei was confirmed by direct measurement of the area of each nucleus. Freeze-dried samples of cerebellar tissue taken from the medial lobe by the method of Chance and Yaxley[4], after fixation in ethanol and embedding in paraffin wax, were cut transversely to the axis of the brain 15μ thick (since the average diameter of the nuclei of resting mice was 6·3μ) and stained with Harris's hæmatoxylin. Measurements were made only on whole nuclei at the periphery of the sample, where freeze-drying artefacts were absent. The area of a number of nuclei in five different parts of each section was measured; these measurements were repeated on sections from different mice receiving the same treatment (Table 1). The area of each nucleus was assessed in arbitrary units comprising the squares (to the nearest half-square) included in a camera lucida projection of the nucleus on to standard graph paper. These were then calibrated in μ^2.

This technique has been used for examining the changes in the dimensions of the nuclei of neurones of the molecular layer following the activities summarized in Table 1.

Table 1

Experimental details					Dimensions of nucleus viewed in transverse sections	
					Area (μ^2)	
Activity of mouse	Severity of treatment	Time relations of treatment and sampling	No. of mice	Total No. of nuclei measured	Mean	S.D.
1. Resting	—	—	5	116	26·95	6·74
2. Anæsthetized	'Seconal' A.D. 100 : 51 mgm./kgm. subcutaneous	Sampled while anæsthetized 15 min. after injection of 'Seconal'	5	120	22·74	5·66
3. Convulsed	'Metrazol' C.D. 50 : 20 mgm./kgm. intravenous	Sampled within 5 sec. of end of continuous clonic convulsion lasting not more than 30 sec. in each mouse	2	48	17·28	3·70
4. Convulsed	'Picrotoxin' C.D. 50 : 5 mgm./kgm. intravenous	Sampled within 5 sec. of end of intermittent convulsions lasting 5, 6 and 10 min.	2	49	17·52	11·58
5. Falling convulsion*	3 × 10 ft. fall	3 falls completed within 30 sec. Sampled within 5 sec. of last fall	5	125	10·91	3·35
6. Running	100 ft. in 5 min. To exhaustion. 200 ft. in 10 min.	Sampled within 5 sec. of end of run Sampled within 5 sec. of end of run	3 3	67 70	35·04 37·33	9·04 12·48
7. Swimming	To exhaustion. 5, 10 and 12 min.	Sampled within 5 sec. of end of swim.	3	69	39·51	12·59

* See refs. 2 and 4.

Each treatment produced changes in the area of the nuclei, with confidence limits below 1 per cent, compared with nuclei from the resting mice. It is clear, therefore, that the different types of behaviour were reflected in changes in the dimensions of the nucleus, as assessed by the measurement of the area in transverse section. Although these changes probably reflect a change in volume, this is not certain in the absence of complementary measurements of the nuclei in sections cut longitudinally to the axis of the brain.

The standard deviation for each treatment group shows wide variation between treatments. It should be noted that whenever the activity includes periods of exhaustion ('Picrotoxin' induces intermittent seizures separated by periods of exhaustion), the variation is high. This could reflect the influence of recovery processes proceeding at different rates in each mouse, the different parts of the brain, or the separate nuclei. An analysis of variance revealed that only in the instance of swimming to exhaustion was there a significant difference between mice as well as a significant contribution to variance from parts of the brain (areas) and from area/mouse interaction. Significant differences between areas occurred in treatments 3 and 7, and area/mouse interactions were significant in 3 and 6.

The full details and analysis of results will be published elsewhere.

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Action of Ascorbic Acid on Corticotropin

Holzbauer and Walter[1] have recently reported that the adrenal ascorbic acid – depleting properties of corticotropin are destroyed by treatment with ascorbic acid at room temperature for 18–20 hr. The corticotropin preparation used by these workers had a potency of 3 I.U./mgm. In view of the potential importance of their observation, we have repeated their experiment using highly purified corticotropin. The preparation used was a sample of corticotropin A_1 (for nomenclature, see Dixon and Stack-Dunne[2]), made in this laboratory by ion-exchange chromatography of an oxycellulose concentrate of pig corticotropin. This preparation had a potency of 110 I.U./mgm. when assayed by the adrenal ascorbic acid – depletion method of Sayers, Sayers and Woodbury[3].

A solution of corticotropin *A*, containing 0·4 I.U./ml. in Ringer solution, was divided into two portions. One portion was kept as control while ascorbic acid was added to the other portion to give a final concentration of 0·084 mgm./ml. Both solutions were kept for 18 hr. at 25°. These conditions and concentrations are identical with those of Holzbauer and Walter[1]. Both solutions were diluted for bioassay by the adrenal ascorbic acid – depletion method. The solution treated with ascorbic acid assayed 147 per cent of the control ($p = 0{\cdot}95$, 76–282 per cent).

Our results are thus in contradiction to those of Holzbauer and Walter. The increase in potency found is of doubtful significance, but could be explained by the protective action of ascorbic acid against autoxidation of the hormone[4].

The difference in the observations is most probably explained by the low potency of the preparation used by Holzbauer and Walter. The ascorbic acid may act by activation of proteolytic enzymes present in the impure preparation. The presence of such enzymes in crude pituitary extracts has already been demonstrated[5].

It must be concluded, therefore, that ascorbic acid has no effect on purified preparations of corticotropin.

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Prof. Morris's results are in good agreement with the observation of Holzbauer and Rigler[1] that the time necessary for the inactivation by ascorbic acid of the melanophore-expanding activity of pituitary extracts increased with increasing purity of the preparation. In these experiments, however, 88 per cent of the melanophore activity disappeared in 28 hr. even when the activity of the preparation was 150 I.U. of corticotropin per mgm. It is regrettable that a highly active preparation was not available to us when the experiments with K. Walter were carried out.

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Reactions between Amino-Acids, Organic Acids and Sugars in Freeze-dried Apricots

Haas and Stadtman[1] separated an apricot concentrate (30 per cent solids) into cationic, anionic and neutral fractions and showed that browning occurred when any two fractions were combined and stored at 57° C. The reactions of individual cations, anions and neutral compounds in freeze-dried apricot *purée* stored at 25° C. and 70 per cent relative humidity (79 per cent solids) have now been studied. After sixteen months, this material was a mid-brown colour. It contained 1-deoxy-1-(N-amino-acid)-fructoses[2] and traces of 2-deoxy-2-(N-amino-acid)-glucoses[3], together with sucrose, glucose and (traces of) fructose half-esters of malic and citric acids. These compounds replaced almost quantitatively the apparent losses of free amino-acids and malic and citric

acids. After allowing for these reactions, there was a loss of 11 m.moles of glucose and 8 m.moles of fructose per 100 gm. fruit solids. It appears that, at this relatively early stage of browning, the coloured compounds were formed from sugars without the incorporation of any significant amount of amino-acid or organic acid residues. If the 1-deoxy-1-(N-amino-acid)-fructoses were intermediates in browning, subsequent reactions must have included the release of the amino-acid[4]. The behaviour of glucose-6-phosphate[5] suggests that the malic and citric acid esters may also be important intermediates in browning.

Equivalent quantities of apricot purée and browned freeze-dried *purée* were extracted with 80 per cent ethanol. The soluble cations and anions were separated by displacement chromatography on columns of sulphonated polystyrene[6] and 'Dowex-1-*X4*' in the acetate form[7]. The compounds were identified by their order of emergence from the columns and by their behaviour on paper chromatograms. Appropriate fractions were combined for quantitative analysis. The soluble neutral components were examined and estimated by paper chromatography.

The amino-acids (as m.moles/100 gm. fruit solids) present before and after browning were: asparagine (7·3, 1·3), aspartic acid (1·8, 1·0), proline (0·5, 0·5), glutamic acid, serine, alanine, γ-amino-butyric acid, threonine, valine, glutamine, glycine, phenylalanine, leucine, pipecolic acid, and traces of tyrosine, histidine, arginine and unknowns (1·8, 1·1). There was also some ammonia (4·6, 4·1, estimated in the alcoholic extract). After browning, at least twelve compounds (*F*1–*F*11 and *X*1) emerged from the columns before aspartic acid (total, 7·1 m.moles by weight, calculated as 1-deoxy-1-asparagino-fructose). In addition, at least six compounds (*Y*1–*Y*6) emerged between the amino-acids and ammonia (total, $< 0{\cdot}5$ m.mole). Tests in solution and on paper indicated that *F*1–*F*11 were 1-deoxy-1-(N-amino-acid)-fructoses. The main component (*F*4) gave asparagine when heated with 0·1 *N* acetic acid. Others gave aspartic acid, serine, threonine, alanine and valine. *X*1 appeared to be 2-deoxy-2-asparagino-glucose, *Y*1–*Y*3 were 1-deoxy-1-amino-fructoses and *Y*4–*Y*6 were 2-deoxy-2-amino-glucoses.

The acids present (as m.moles/100 gm. fruit solids) before and after browning were: malic (50·5, 42), citric (9·8, 8·4), and small quantities of quinic, phosphoric, succinic and unknown acids. After browning, some new acids emerged from the columns before and with quinic acid; hydrolytic experiments showed that they were sucrose, glucose and fructose half-esters of malic acid (total, 6·5 m.moles). Similar esters of citric acid emerged just before malic acid (total, 1·5 m.moles).

The neutral components found were sucrose (before browning 100 m.moles; after, 67), glucose (79, 86), fructose (60, 80), xylose (1, $< 0{\cdot}5$), a ketose oligosaccharide, inositol, and sorbitol. Some sucrose (4 m.moles) was combined as esters, and it was assumed that 29 m.moles were hydrolysed to glucose and fructose. Approximately 1 m.mole of fructose and 11 m.moles of glucose were found combined in esters and amino-acid derivatives, leaving 8 m.moles of fructose and 11 m.moles of glucose not accounted for and presumably involved in the production of brown pigments.

Similar results have been obtained with freeze-dried peach *purée* stored under the same conditions for fifteen months.

This work, which will be reported fully elsewhere, was carried out as part of the research programme of the Division of Food Preservation and Transport of the Commonwealth Scientific and Industrial Research Organization, Australia.

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The *Diego* Blood Factor in Chinese and Japanese

The *Diego* blood factor was originally reported by Levine, Koch, McGee and Hill[1] in 1954, as a 'private' blood factor. A year later, studying the incidence of the *Diego* factor on Venezuelan subjects, we found[2] that it is relatively common in two stocks: 50 positive cases out of 170 Caribe Indians and 8 out of 152 Arawaco Indians. It was also present, although in low incidence, in people from Caracas and Barcelona (Venezuela) where Indian admixture was already known.

The serological independence of this factor from other blood factors was demonstrated by Levine, Robinson, Layrisse, Arends and Dominguez Sisco[3]. Its incidence has been studied by Junqueira *et al.*[4] in Carajás and Kaingangues Indians from Brazil, showing respectively 36 and 48 per cent of positives. Piaroa and Guahibo Indians living in Territorio Amazonas (Venezuela), who are anthropologically independent from all Indians mentioned above, also carry this antigen[5]. The Piaroas showed 3 *Diego* positive (12·5 per cent) out of 24 samples, and the Guahibos, 11 out of 76 (14·47 per cent).

Consistently negative results have been obtained in a thousand Caucasoids of the United States[3], two hundred random Dutch (van Loghem, personal communication), a hundred and fifty Spaniards and two hundred Italians (tested by us).

Since the Indians of the American continent are considered to be anthropologically related to the Mongoloid people of the Old World, we decided to investigate the incidence of the *Diego* factor in other available representative Mongoloids living in Venezuela. We now report our findings in Chinese subjects.

One hundred unrelated male Chinese from Canton (China), living in Venezuela, were selected for this study. Their physical features were typically Chinese and there was no admixture with the Venezuelan natives. The blood samples were tested against anti-*Di*[a] serum by the indirect Coombs test as previously reported[2]. *Rh* factors (*C*, *c*, *D*, *E*), A_1A_2BO, *MN* and *Duffy* blood groups were tested by standard methods. Table 1 shows the results.

The frequencies of A_1A_2BO, *MN* and *Duffy* found in this study are very close to those already reported[6].

Table 1. Frequency of A_1A_2BO, *MN*, *Rh*, *Duffy* and *Diego* in 100 Chinese from Canton

A_1A_2BO system									*MN* system					*Duffy* system			
Phenotypes (per cent)					Genes (per cent)				Phenotypes (per cent)			Genes (per cent)		Phenotypes (per cent)		Genes (per cent)	
A_1	A_2	B	A_1B	O	P_1	P_2	q	r	M	MN	N	M	N	$Fy(a+)$	$Fy(a-)$	Fy^a	Fy^b
28	4	25	2	41	16·55	2·45	14·65	66·30	21	59	20	50·5	49·5	100	0·0	100	0·0

RH system										*Diego* factor			
Phenotypes (per cent)						Chromosomes (per cent)				Phenotypes (per cent)		Genes (per cent)	
CCDE	*CCDee*	*CCddee*	*CcDE*	*CcDee*	*ccDE*	*CDE*	*CDe*	*Cde*	*cDE*	*Di(a+)*	*Di(a−)*	Di^a	Di^b
8	45	1	17	25	4	5·55	66·82	1·00	26·82	5	95	2·54	97·46

As regards the *Rh* system, all but one were $Rh_0(D)$ positive. The *CDe* and *cDE* chromosomes have the incidence found by other investigators in Chinese[7]; the *CDE* chromosome was rather high (5·82 per cent) and the only Rh_0 negative found was a sample of phenotype *CCddee*.

The outstanding feature of this study was the detection of five *Diego*-positive Chinese (5 per cent). This finding indicates that the *Diego* factor is not restricted to South America. It indicates also that it could be present in all countries where Chinese have entered as part of the population.

The persistent absence of the *Diego* factor in all Caucasoids studied up to date and its presence in six South American Indian stocks and in Chinese suggest that this antigen is Mongoloid rather than Indian. It would not be surprising to find it in other Mongoloid branches.

The finding of the second sample of *Diego* antibody in a Polish couple, apparently unrelated to South American Indians, could not be explained before[8]. However, in the light of our findings in Mongoloids (Chinese and South American Indians), the presence of this antigen in a Polish family may be interpreted as indicative of Mongoloid admixture.

These facts indicate that besides its clinical importance (two cases of hæmolytic disease already known), the *Diego* blood antigen has a potential anthropological significance.

Dr. Albin Opalinski and Miss Abilia Rojas gave us technical assistance.

Subsequent to the submission of this manuscript for publication, we have studied sixty-five unrelated Japanese, finding eight *Diego* positives (12·30 per cent)[8].

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The Blood Group Antigen *Diego* in North American Indians and in Japanese

The blood group antigen *Diego* has been reported to be present with not inconsiderable frequency in Indians of South America[1], but absent in 1,000 Caucasoids in the United States[2]. The second example of anti-*Diego* was identified by Levine and Robinson (unpublished observation) in a specimen submitted by Witebsky and Rosamilia. Using the latter serum, we have found the antigen *Diego* to be present in 16 of 148 unrelated Chippewa Indians in northern Minnesota, and 6 of 77 unrelated Japanese in Winnipeg. This suggests that *Diego* may be an Asiatic character. The family in which Witebsky and Rosamilia found anti-*Diego* was Polish, and we know from the frequency of the gene *B* that there is probably a somewhat greater admixture of Asiatic blood in Poland than there is farther west in Europe. The antigen *Diego* promises to be of great anthropological interest.

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The Carotid Body of the Pilot Whale, *Globicephala melaena*

Heymans[1] has shown that mammalian blood pressure and respiration-rate are largely regulated by chemoreceptive cells which are innervated by the glossopharyngeal nerve. These are situated near the bifurcation of the common carotid artery (carotid body) and at the base of the great arteries (aortic body).

So far, no conclusions have been reached as to the ontogenetic relationship between receptor cells and their innervation. Some consider this system consists of two separate units[2]—mesodermal receptor cells which are eventually innervated—while others suggest a purely nervous organization in which receptor cells represent modified ganglion cells[3].

Sensitivity to blood composition, as found in the carotid body, would then be a function of nervous tissue alone.

This latter view may find support in the present work on the carotid body of the pilot whale. It was possible to obtain fresh material from pilot whales stranded in Orkney during March 1955.

The structure of the carotid body was found to differ from those so far investigated in the intimate relationship between receptor cells and ganglion cells. The presence of small numbers of scattered ganglion cells, especially on the periphery of the carotid body, is well known[4]. They usually occur singly and are small in size. By contrast, in the pilot whale, large accumulations of compact masses of ganglionic tissue are incorporated into the carotid body, amounting to clusters of ten to twenty cells per 10μ section. These ganglion cells are identical in appearance with those found in peripheral autonomic ganglia and they show the same variation in size and range of staining reaction. The difference, however, lies in the fact that in many instances sinusoids, typical of chemoreceptive tissues, are seen to ramify between the ganglion cells. In such cases the sinusoids are surrounded by a few chemoreceptive cells, or by a body of a large ganglion cell on one side, while chemoreceptors lie close to the ganglion cell and the sinusoid. Such a modified ganglionic tissue is also frequently found embedded in the branch of the glossopharyngeal nerve as it approaches and penetrates the carotid body. Indeed, those tissues occur more frequently alongside and in the vicinity of the nerve supply to the carotid body than farther away from it, and as in this case the supplying nerve passes straight through the carotid body, they often command a fairly central position.

The carotid body of the pilot whale consists of innumerable large and small lobes separated by connective tissue so as to form a rather diffuse organ. A considerable variation is found in the structure of these lobes, which may contain chemoreceptive tissue, ganglionic tissue or a combination of the two in varying proportions. Often ganglion cells, bundles of myelinated and unmyelinated fibres and chemoreceptors are united into comparatively small glomeruli by well-developed connective tissue capsules (Fig. 1).

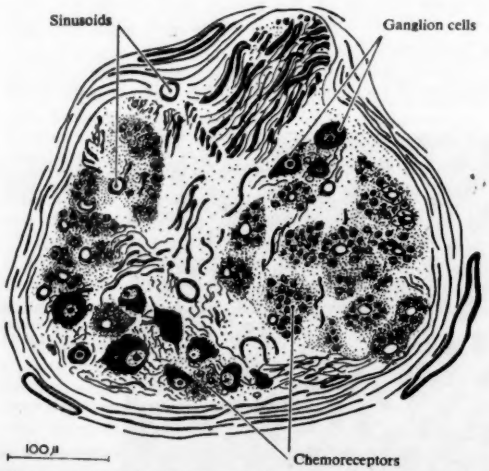

Fig. 1. Section of a glomerulus of the carotid body of the pilot whale, showing a mixture of ganglionic and chemoreceptor cells. Holmes's silver stain

It was found that the modifications of the carotid body of the pilot whale—one of the Odontoceti—are not shared by the Mystacoceti such as the finner whale, *Balaenoptera physalus*.

Detailed reports on both types of carotid body will be published elsewhere.

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Separation of Epidermis from Dermis by Filtrates of *Trichophyton mentagrophytes*

ALTHOUGH fungi of the *Trichophyton* group have been shown to be capable of digesting keratin[1], little attention has been given to the possibility of their liberating toxic substances. As early as 1896, Macfadyen[2] showed that cultures of *T. tonsurans* liquefied gelatin by means of a diffusible enzyme, but this appears to have been overlooked in subsequent consideration of the pathology of dermatophytes. As part of an investigation into the pathogenicity of dermatophytes, studies have been made of the effects of filtrates of *T. mentagrophytes* upon skin. The fungus has been cultured upon a simple fluid medium which will also support the respiration of skin and exercise no toxic effects when portions of skin are 'cultured' in it for a period of five hours. The culture medium consisted of 12·9 ml. Krebs–Ringer phosphate, 1 ml. 10 per cent glucose, 1 ml. 2 per cent glycine, 1 ml. 1 per cent ammonium chloride and 0·05 ml. of a mixture of zinc sulphate, manganese sulphate and ferrous sulphate, each 1 mgm./ml. The constituent fluids were sterilized separately and mixed when cold. This amount of medium formed a shallow layer in a 20-fl. oz. screw-capped bottle laid flat.

A heavy inoculum of aerial mycelium from beer-wort agar cultures of *T. mentagrophytes* was added and incubated at 28° C. After fourteen days, the growth formed a mat over the surface of the fluid. Some slimy mycelial growth also occurred below the surface. The medium was then decanted and a fresh supply added. This was repeated at two fortnightly intervals. After this time the growth appeared to degenerate somewhat. The decanted fluid was sterilized by Seitz filtration and then stored at 0° C.

Tests for proteolytic activity were made by examining the effects of the filtrate upon dyed hide-powder ('Azocoll') and congo-red-fibrin. The former tests were made semi-quantitative by measuring the release of dye colorimetrically. In addition, the ability of the filtrate to liquefy gelatin and to hydrolyse salivary mucin was tested, the latter being carried out by the method of Sammons[3].

As commercial trypsin has been shown to cause separation of epidermis from dermis[4], portions of guinea pig ear skin were incubated with the filtrate in a similar manner.

In all tests two types of 'controls' were included—of uninoculated fungus medium and of boiled filtrate.

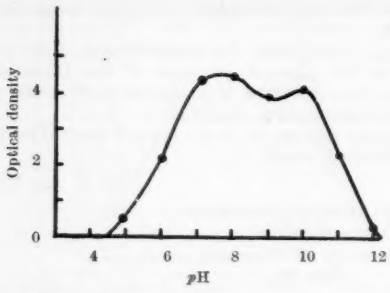

Fig. 1. The dye release from 'Azocoll' by filtrates of *T. mentagrophytes* in relation to *p*H

Release of dye from 'Azocoll' hide-powder was rapid—the undiluted filtrate showing activity within half an hour. Estimations of the release of dye over a range *p*H 4–12 indicate a wide range of activity from *p*H 6 to *p*H 11 (Fig. 1). There appeared, however, to be two maxima—about *p*H 7 and about *p*H 10. In repeat experiments the exact location of the peaks was not precise; but the reduced activity between the maxima was always present. The experimental method, however, is not precise enough to define accurately the exact maxima.

The release of dye from congo-fibrin was considerably slower, at least four hours incubation being necessary. The range of *p*H over which activity appeared was similarly *p*H 6–11.

Sammons's test, which depends upon the ability of mucin to cause clumping of a suspension of barium sulphate, and the impairment of this property after enzymic digestion, also gave a positive result. Digestion of salivary mucus took place after about two hours.

Gelatin liquefaction occurred after incubation overnight, and similarly decolorization of denatured hæmoglobin was shown by allowing the enzyme to diffuse through a hæmoglobin-agar plate incubated at 37° overnight.

Finally, it was shown that incubation of thin slices of guinea pig ear skin with the filtrate so affected the epidermal–dermal bonds that the epidermis could be separated from the dermis by fine forceps. About two hours incubation was necessary, and this represents the time required for a solution of commercial trypsin 12·5 mgm./ml. to induce this loosening of the tissues.

Serum inhibited the skin-splitting effects of the filtrate and it also inhibited the hydrolysis of 'Azocoll' and hæmoglobin.

A filtrate from a culture of *T. rubrum* has also been examined and was found to have similar properties.

These results indicate that filtrates of *T. mentagrophytes* contain an enzyme or enzymes which are proteolytic. The wide *p*H range of activity and the two optima for the release of dye from 'Azocoll' suggest that more than one enzyme may be present.

The separation of epidermis from dermis by commercial trypsin has been stated to be due to the presence of an elastase[5]. We have found, however (unpublished observations), that a crystalline trypsin, although less effective, will also cause skin-splitting. The mucinase isolated by Sammons[3] will also split skin, and consequently this skin-splitting property gives no indication of the nature of the protease present.

However, the knowledge that *T. mentagrophytes* produces an enzyme which can cause separation of epidermis from dermis throws some light on the pathology of fungus infections. It is reasonable to believe that, as the fungus grows in the more superficial layers of the epidermis, the proteolytic enzyme diffuses from it and loosens the epidermal attachments. Thus in areas exposed to friction, vesicles will readily appear.

The proteolytic enzyme may be responsible for the itching associated with epidermophytosis. Arthur and Shelley[6] have shown that the injection of proteases into the skin is accompanied by itching.

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Occurrence of Triple and Quadruple Cones in the Retina of the Minnow (*Phoxinus laevis*)

Triple cones have previously only been observed in the retinæ of a frog, *Rana temporaria*[1], and of a gecko, *Aristelliger praesignis*[2], and in both these animals they are rare and atypical. I have examined many retinæ of trout, *Salmo trutta*, of all ages, and I have found a considerable number of triple cones which, from their distribution in the cone pattern, appear to be anomalous double cones. In the minnow, however, triple cones are abundant and predominate in most regions of the retina, and quadruple cones are numerous enough to suggest that they may have a significant function.

These multiple cones are seen most clearly in tangential sections of the retina (Fig. 1). In several

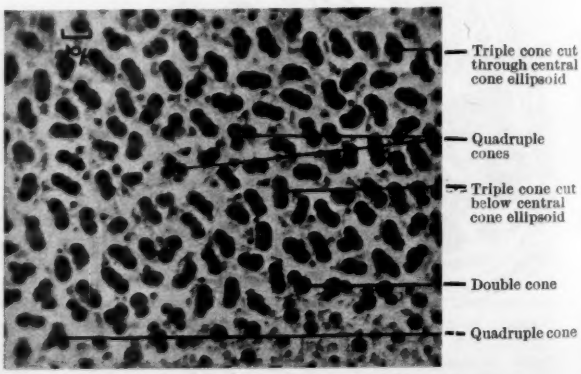
Triple cone cut through central cone ellipsoid
Quadruple cones
Triple cone cut below central cone ellipsoid
Double cone
Quadruple cone

Fig. 1. Tangential section from the fundus of a minnow retina

sections the quadruple cones are proportionately more numerous than in Fig. 1. The three parts of a trout triple cone are of equal size; but a minnow triple cone consists of a large central cone with two smaller cones arranged linearly on opposite sides of it, and a quadruple cone has three smaller cones placed symmetrically around the central cone. Each part of a multiple cone resembles a typical teleost single cone in structure, having a small outer segment, a larger inner segment with an ellipsoid, and a nucleus and foot-piece. In the minnow, the ellipsoid of the central cone is level with the outer segments of the smaller lateral cones, so that in a tangential section all the ellipsoids of one multiple cone are not visible.

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Site of Hibernation of a Tachinid Larva within its Host

During investigations on the physiological relations between the pine looper, *Bupalus piniarius* L. (Lep. Geometridae), and its parasite *Carcelia obesa* Zett. (Dipt. Tachinidae), some interesting facts were discovered, which so far as we know have not hitherto been described.

The egg of *Carcelia obesa*, which is deposited on the young caterpillar, contains a well-developed maggot which forces its way into the host within a few hours. Reaching the hæmocœl, the maggot creeps towards the head of the caterpillar and penetrates into a mandibular muscle. (According to Klomp[1] the larvæ attach themselves first to the wall of the fore-intestine.) The muscle reacts by the formation of a protruding hypertrophy, in which the resting maggot stays during the larval life of its host. *Bupalus* passes the winter in a state of pupal diapause. When in the autumn the caterpillar pupates, and the mandibular muscles go into histolysis, the maggot (still in its first stage) is again released into the hæmocœl. However, when dissecting parasitized pupæ in November and December, one finds the maggot mostly in a cavity between the abdomen and the wings, and consequently outside the body of the future moth. This cavity not only contains exuvial fluid, but also a quantity of air which communicates with the first pair of abdominal stigmata, lying inside the sclerotized pupal cuticle under the wing base. More than once we have taken the maggot in the act of holding its caudal stigmata in contact with the air bubble.

Whether the maggot reaches the cavity actively, or whether it is ejected by the host, is still being investigated. The maggot resumes its development as soon as diapause in its host is broken and adult development initiated.

Clearly the subalare air-mass of the host pupa is of great importance to the hibernating parasite. The question arises, What is its significance for the host itself?

We have found air bubbles in the subalare cavity of all pupæ of Lepidoptera so far examined: *Pieris brassicae* L., *Sphinx ligustri* L., *Automeris io* Fabr., *Philosamia walkeri* Felder., and *Phalera bucephala* L. Only in *Pieris* and *Bupalus* did the air occupy the greater part of the cavity. In *Pieris* its volume may even exceed that of the abdomen. At first we thought this might be the clue to the intermittent release of considerable quantities of carbon dioxide during diapause by lepidopterous pupæ, as demonstrated by Punt[2], Schneidermann and Williams[3,4] and Buck[5]. However, the quantity of 'subalare air' was found to be relatively small in *Philosamia walkeri*, in which Schneidermann and Williams[4] have apparently found discontinuous respiration.

Most probably the air compensates for the loss of body water during the long period of hibernation, and thus provides a possibility of shrinking, which in the *pupa obtecta* is not otherwise provided for.

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Observations on Pool and Capillary Feeding in *Aedes aegypti* (L.)

Gordon and Lumsden[1], in a classical paper, first directed attention to the fact that mosquitoes take up blood either directly from a capillary or from a pool formed in the tissues by the leakage of blood from a capillary previously lacerated by the mosquito's proboscis. The former method was termed 'capillary feeding' and the latter 'pool feeding'. It was also noted that, when a mosquito fed from a capillary, engorgement took about three minutes as compared with as long as ten minutes when the blood was taken by pool feeding. Attention was also directed to the significance of the two methods of feeding in relation to the taking up and deposition of pathogens by mosquitoes. These experiments were performed on the frog's web, using *Aedes aegypti* (L.), and were criticized[2] on the grounds that the mechanism of feeding might be very different in mammalian tissues. Recently, Griffiths and Gordon[3] developed a new technique for making observations on mosquitoes while they fed on the mouse's ear. Using this technique it was possible to show, by direct observation on living mammalian tissue, that no essential difference existed between the method used by mosquitoes while feeding on batrachian and mammalian tissues.

In view of the medical significance of these two types of feeding, it was considered of interest to determine the differences in the times taken by *A. aegypti* to engorge when feeding on man. It was hoped that such observations would indicate the frequency of the two types of feeding when man was host to the mosquito.

During the course of studies on the reactions of medical students to the bites of *Aedes aegypti* (L.)[4], records were kept of the time taken by each mosquito to fill to repletion (T_r). All observations were made at room temperature, which varied from 22° to 24° C. during the course of the observations. The mosquitoes all came from the same colony and had not had a

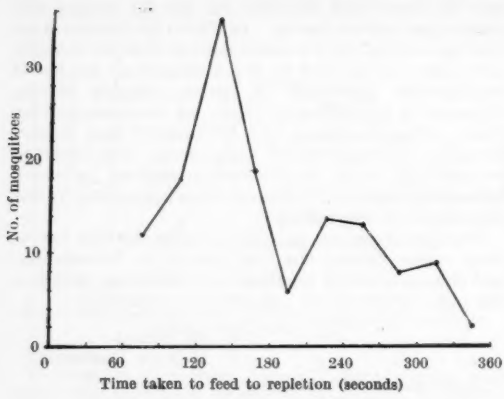

Fig. 1

previous blood meal. In all, 140 observations were made on seventy-five medical students, each observation being made on a separate mosquito. The time interval T_r was taken from the insertion of the proboscis to its final withdrawal after the mosquito had fed to repletion. Preliminary probings which ended by the proboscis being completely withdrawn and the mosquito failing to obtain blood were not included. Probing which did not result in the withdrawal of the proboscis but which was a preliminary to engorgement was included in the time T_r. The mean for T_r was 189 $\pm$ 77 sec. The results obtained are shown in Fig. 1.

The markedly bimodal distribution pattern of T_r shows that two groups occur in the population sampled. In the absence of other obvious differences between the mosquitoes used, it is reasonable to suggest that the two groups are capillary and pool feeders respectively. If we then assume that a mosquito feeding from a capillary takes 180–210 sec. as a maximum feeding time and that the pool feeders take at least 180 sec. to feed to repletion, we may then include the six specimens in the class 180–210 sec. with both groups. The mean time to repletion for capillary feeders then becomes 131 $\pm$ 33 sec. and for pool feeders 267 $\pm$ 50 sec. These means are highly significantly different when Students' T test is applied (P is less than 0·001). It will be noted that capillary feeding occurs more frequently than pool feeding, the latter method of feeding being used by about 40 per cent of *A. aegypti* feeding on man.

These results confirm Gordon and Lumsden's findings[1] and, although the direct observation in man of the two types of feeding is virtually impossible, show that there is strong evidence that the two types do occur. These observations were made while I was employed by the Unit of Veterinary and Medical Entomology, Science Service, Ottawa, Canada.

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Effects of Gamma-(2 : 4-Dichlorophenoxy)-butyric Acid on Sporelings of Bracken

Among their recent studies of the chemistry and mode of action of plant growth-substances, Wain and his co-workers[1] have demonstrated that a β-oxidation system exists in certain plants, whereby usually inert formulations of certain ω-phenoxyalkyl carboxylic acids may be broken down in the plant to the active acetic derivative. Since this is an enzymatic reaction, there seems no reason why such oxidation should not take place in all classes of plants; but the examples so far described belong to the Angiosperms. It is therefore of interest to note that positive growth reactions have been shown by young plants of the common bracken fern (*Pteridium aquilinum*) when treated with γ-(2 : 4-dichlorophenoxy)butyric acid (2 : 4-D.B.).

During recent tests of the effects produced by certain chemicals on 1-yr. bracken plants growing under garden conditions, three test plants were each sprayed with 10·5 c.c. of a water solution of γ-(2 : 4-dichlorophenoxy)butyric acid at a concentration of 500 p.p.m. These plants (and others which were used as untreated controls) were chosen for uniformity of frond growth, and each (in addition to a central group of very small juvenile fronds, most of which were short-lived) had sixteen to eighteen fronds of 33–38 cm. height. Spraying was carried out on August 9, and eight days after treatment two of the three treated plants showed epinastic curvatures on the stalks of the youngest, elongating fronds. Four weeks after treatment, the plants were growing vigorously; but many of the fronds showed epinastic curvatures of the frond rachis and marked reduction in pinnule size. These fronds had a more rigid appearance than those of the control plants, and the reduced pinnæ gave the experimental plants a delicate feathery appearance. Fronds developing later tended to have more normal form; but, for the rest of the season, fronds on the treated plants showed a rather stiff, erect habit.

At harvesting, seven weeks after treatment, all three experimental plants showed vigorous frond growth, the number of fronds being greater than that of the control plants. One of the treated plants was dug up, leaving the other two for future observation. The rhizome of this plant showed positive (growth-regulating) reactions, the chief morphological features being: (*a*) restriction of internodal development, which resulted in the extension of the rhizome being much less than that of untreated plants; (*b*) marked contortions and dormancy of the majority of the rhizome apices; and (*c*) increased root formation particularly around the dormant stem tips. As in the case of frond growth, these morphological features were less marked on the younger, later developed, branches of the rhizome.

Such morphological features are all strictly in line with growth effects shown by young bracken plants when treated with the recognized active growth-regulator, 2 : 4-dichlorophenoxyacetic acid (2 : 4-D.). In themselves, they do not prove the breakdown of the butyric compound, and further analysis is needed to show this. But the morphological reactions were marked enough to suggest that the butyric compound was degraded inside the plant to the more active acetic homologue; and that an oxidation mechanism may operate in the tissues of the bracken sporophyte, at any rate in the early stages of development.

Acknowledgment is made to the Agricultural Research Council for its support of this work, and to Messrs. May and Baker, who supplied samples of γ-(2 : 4-dichlorophenoxy)butyric acid for testing.

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Effect of the Anion on R_F Values of Quaternary Ammonium Salts

THE effect of anions on the R_F value of cations is in most cases ignored, since little interaction has ever been found to exist. Pollard *et al.*[1] refer to the different R_F's of various cupric salts and also demonstrate that lead, sodium and potassium move separately from their respective anions. Lederer[2] states that butanol saturated with 0·5 *N* ammonium hydroxide keeps halide salts completely in the ionic form and that they move as ions. Others[3] have noted different R_F's with several salts of acetylcholine.

While studying the *in vitro* metabolism of the ganglionic blocking agent, 'Ecolid' chloride (4,5,6,7-tetrachloro-2-(2-dimethylaminoethyl)-*iso*indoline dimethochloride)[4], we noticed that after precipitation of tissue proteins with trichloracetic acid, paper chromatograms of the acid solution yielded one spot with R_F value 0·67, whereas 'Ecolid' chloride itself gave R_F 0·18. If, however, 'Ecolid' was precipitated with reinecke salt and the reineckate chromatographed after treatment of the material at the origin with silver nitrate to split the salt[5], a spot with R_F 0·23 resulted. A possible explanation for these phenomena is that salts of 'Ecolid' migrate in undissociated form. Therefore, the trichloracetic acid filtrate would give a spot of 'Ecolid' trichloracetate whereas silver nitrate treatment of the reineckate would yield a spot of 'Ecolid' nitrate.

To test this hypothesis, a solution of 'Ecolid' chloride was passed through an anion exchange resin, 'Permutit S-2', and the 'Ecolid' hydroxide thus obtained was added to various salt solutions. Aliquots of these solutions were then subjected to ascending paper chromatography along with the 'Ecolid' hydroxide using two solvents. Solvent *A* consisted of *n*-butanol saturated with 0·1 *N* ammonium hydroxide, whereas solvent *B* consisted of 20 per cent ammonium hydroxide in 95 per cent ethanol. In all cases identification of 'Ecolid' was by spraying the chromatogram with a modified Dragendorff solution[5].

It is apparent from Table 1 that the nature of the anion markedly affects the R_F of the 'Ecolid' cation. The iodide and trichloracetate salts of 'Ecolid' are relatively insoluble and crystals of each have been obtained which are homogeneous by paper chromatography. The iodide displays the same R_F as one prepared by another route.

Shepherd and West[6] describe the appearance of a second adrenaline-like spot in trichloracetic acid filtrates, which seems to be a complex of trichloracetic acid and adrenaline. They suggest compound formation between the weak phenolic group of adrenaline and trichloracetic acid as the cause. Simple salt formation between adrenaline cation and trichloracetic acid anion, similar to that observed with trichloracetic acid and 'Ecolid', could easily explain the effect observed by Shepherd and West.

Table 1

Anion	R_F of 'Ecolid™' in solvents	
	*A**	*B**
Hydroxide	0·15–0·16	0·10–0·13
Fluoride	0·18	0·18–0·19
Chloride	0·18	0·45–0·5
Bromide	0·24	0·52–0·54
Iodide	0·25–0·29	0·62
Carbonate	0·58	0·25–0·27
Nitrate	0·23–0·24	0·51–0·52
Acetate	0·56	0·51
Phosphate	0·61–0·63	0·74
Sulphate	0·64–0·65	—
Trichloracetate	0·65–0·69	0·77

* See text for composition.

The effect of anions on the R_F of cations, in this case a bisquaternary ion, emphasizes that care must be taken in the interpretation of chromatograms from natural fluids or tissue extracts. The danger of loss of material due to the formation of relatively insoluble salts was underlined by our observation of a sparingly soluble 'Ecolid' trichloracetate in trichloracetic acid filtrate preparations. Therefore, standard solutions should not be prepared with simple solvents but with the fluid or tissue extract under consideration.

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Arcs in Vacuum

DURING an investigation of the behaviour of electric arcs in vacuum, measurements have been made of arc voltages with various cathode materials, and photographs have been taken of cathode spot tracks on one particular material. Certain of these measurements may be relevant to phenomena occurring at the opening of low-current contacts in air.

To enable an arc to burn in a high vacuum, one electrode at least must vaporize. In all the tests made, the cathode provided the vapour from high current-density cathode spots.

Although the arcing voltages were exceedingly ragged, the average arcing voltage depended on the cathode material, as did the current necessary to maintain a stable arc. A solid cadmium cathode, for example, allowed a 2-amp. arc to burn steadily, whereas an arc with a tungsten cathode was unstable even at 50 amp. Oscillograph records showed no sign of a change of average arc voltage as an initially clean steel anode became coated with vapour from the cathode, and when cadmium was used as the cathode, heating the anode to a temperature above the boiling point of cadmium did not affect the average arcing voltage.

The anode was a flat steel disk about 2 in. in diameter, and pieces about ½ in. in diameter were used for cathodes, except in the cases of gold and nickel, when wires were used. The arcs, which were

Table 1

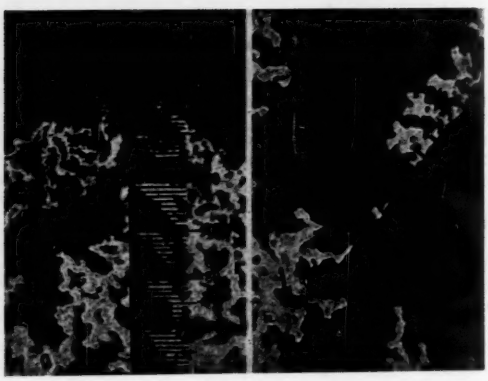
Cathode material	Arc voltage (volts)
Cadmium	10
Magnesium	12
Gold	12·5
Nickel	15·5
Silver	16·5
Aluminium	19·5
Carbon	20
Copper	21
Steel	33
Tungsten	> 50

initiated by separating the electrodes, were drawn to lengths of between 1 and 10 mm.

The voltage gradient of the arc was less than 0·05 V./cm. in every case, and the arc voltage was very nearly independent of the arc current. Some arcing voltages are shown in Table 1.

After arcing had taken place, the cathodes all showed microscopic melting, with the exception of carbon, which had small pits burned into it.

If, instead of using a solid piece of metal for a cathode, a very thin film of metal evaporated on to glass is used, very clear cathode tracks can be obtained. Cathode tracks made by a 1-amp. arc about 2 cm. long on a film of cadmium about 0·02μ thick are shown in Figs. 1 and 2. In this case the arc was initiated by a spark from a third electrode. The narrowest track appeared to be about 0·4μ wide, which is about the same size as those caused by very short arcs on contacts, photographed by Germer and Boyle[1]. It seems likely that the wider tracks are made by the overlapping of narrower tracks, the cathode spots running around the edges of the tracks, and evaporating larger areas. That these cathode spots can be guided by fine scratches, like those shown by Germer and Boyle, is shown in Fig. 2. There is also evidence that the spot tracks become narrower where the metal film is thinner.



Photomicrographs (× 1,200) of cathode tracks on film of cadmium about 0·02μ thick. Current approximately 1 amp. (2) shows effect of very fine scratches guiding cathode spots

A detailed account of this investigation will be published elsewhere in due course. This communication is published by permission of the Director of the Electrical Research Association.

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Formation of the High-Pressure Arc Column in Hydrogen

We have noted[1] that by increasing the current of a hydrogen high-pressure glow discharge between copper electrodes, we cause the discharge column to concentrate gradually until a critical current value is reached, when a sudden marked constriction occurs, resulting in a bright red column[2]. It was noted also that with clean electrodes, the characteristic glow discharge properties at the cathode are not affected by the column changes. We have now observed that similar effects may be obtained using tungsten electrodes.

Our recent experiments give the variation of some of the main properties of the column through the transition region, and typical results are shown in Fig. 1. At low currents the column diameter increases slowly with current; but between 1·0 and 1·5 amp. the column contracts gradually until at about 1·5 amp. a discontinuous constriction occurs, producing a sudden fall in the voltage gradient and a large increase in the current density. The electrical and optical properties of the column are now almost identical with those of the normal hydrogen arc. Measurements of excitation temperatures of Balmer series reveal that a minimum temperature is reached at the value of the constriction current, and that further increase in current produces increased temperatures and a convergence of the separate excitation curves. The results suggest that at low currents the excitation temperatures describe an electron energy

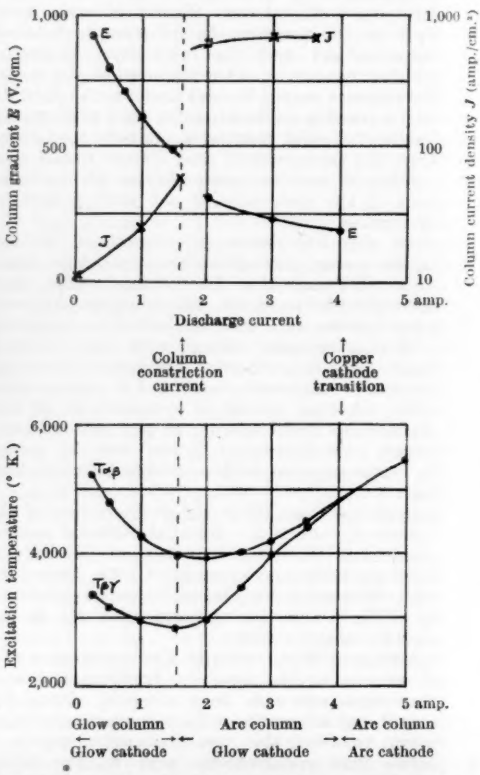

Fig. 1. Hydrogen discharge characteristics: pressure, 1 atmosphere; copper or tungsten electrodes; gap, 5–10 mm.

distribution, and that with increase of current the gas temperature rises from a low value and approaches the electron temperature.

With both tungsten and copper electrodes further increase in current results in a discharge with normal arc cathode and column regions, with, however, no further discontinuous column changes. Thus it may be concluded that the true hydrogen arc column is first formed when the sudden constriction occurs. The experiments show also that the values for minimum excitation temperature are independent of pressure, gap-length and electrode material and always occur at the constriction current. It seems likely, therefore, that the suggestions of King[3] are valid, namely, that the column constriction is dependent upon dissociation and thermal considerations. This view is further supported by our experiments, which show that with water-cooled copper electrodes the constriction occurs at higher current values if the gap distance is decreased, but that the reverse effect is obtained with hot tungsten electrodes.

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Aggregation of Spherical Particles

Fessler[1] has recently directed attention to the existence of pearl-string artefacts in random arrays of spherical glass particles, and suggests that the occurrence of such arrangements in electron micrographs should be accepted with caution in the absence of additional evidence. This communication describes a system in which this phenomenon has been observed using the electron microscope; but at the same time light-scattering measurements have also confirmed the presence of associates of this shape.

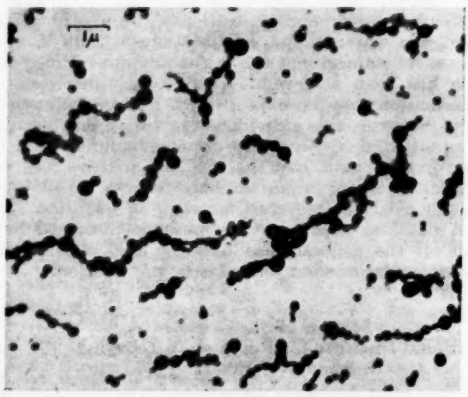

Fig. 1. Electron micrograph of precipitated polystyrene, showing small spherical particles and aggregates. × 11,000

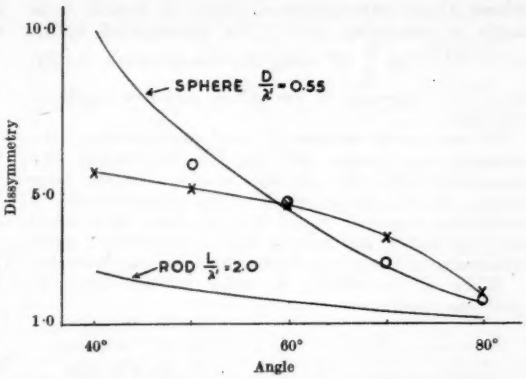

Fig. 2. Plot of dissymmetry against angle, showing the theoretical and experimental results. ○, Initial (5 per cent); ×, final (85 per cent) stages of precipitation

In the turbidimetric method of analysis of polymer solutions, non-solvent is slowly added to the solution, the turbidity being measured as the decrease in transmission of a parallel beam of light passed through the system. The method is useful for estimating the distribution of molecular weight, and also in detecting the presence of 'block' and 'graft' type polymers in the presence of their associated homo-polymers. The polymer is progressively precipitated, and if all this material is present in the form of spherical particles which are small compared with the wavelength of light used, then the decrease in transmission will give an exact measure of the quantity of each molecular species present in the system.

In an analysis of this type, a 0·004 gm./100 ml. solution of a sample prepared in the laboratory of polystyrene of molecular weight 400,000 was used. 30 ml. of this solution together with 12 ml. of methanol was placed in the turbidimeter cell at 25° C. and precipitation brought about by adding more methanol at the slow rate of 0·01 ml./min. with continuous slow stirring.

Electron micrographs of the precipitated material taken at the 50 per cent precipitation point (Fig. 1) show the existence of pearl-string associates. These are very large compared with the individual spheres also present.

Light-scattering measurements were also made on samples taken from the titration cell, the transference being carried out very carefully, in order to exclude contamination by extraneous particulate matter. Intensity measurements were made over the angular range, 40°–140° at 10°-intervals, on samples of the initial (5 per cent) and final (85 per cent) stages of the precipitation.

Fig. 2 shows the dissymmetry of angular scattering at several angles. The dissymmetry is defined as the ratio of the intensity of scattering at the forward angle θ, to that at 180° − θ. Also in this figure are the expected distributions for spherical and rod-like particles of the size indicated, and calculated using the following relationships[2]:

$$P_{(\theta)} = \frac{3}{x^3}\left[(\sin x - x\cos x)\right]^2$$

$$P_{(\theta)} = \frac{1}{x}\int_0^{2x}\frac{\sin x}{x}\,dx - \left(\frac{\sin x}{x}\right)^2$$

where λ' is wave-length of light in liquid, θ is angle of scattering ($\theta = 0$ for transmitted light), $x = \frac{2\pi D^*}{\lambda'} \sin \frac{\theta}{2}$, D^* being the characteristic dimension, D is diameter of the sphere and L is length of the rod.

In the early stages of the precipitation, the experimental points fall on the theoretical line associated with the spherical model. In the later stages the plot shows many of the characteristics of scattering expected of rod-like particles. This would be expected if the sample was a mixture of small spheres and linear aggregates of spherical particles.

Work is proceeding in order to elucidate the problem further.

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March 19.

[1] Fessler, J. H., *Nature*, **117**, 439 (1956).
[2] Debye, P., *J. Phys. and Coll. Chem.*, **51**, 18 (1947).

Latin-Square Designs with Individual Gradients in One Direction

The efficacy of the Latin-square design[1] in eliminating two-dimensional variation from treatment comparisons, particularly in field experiments, has long been established. Kendall[2] states that horizontal and vertical gradients at least are removed from the comparisons, implying, of course, that the three degrees of freedom for columns in a 4×4 Latin square, for example, can be regarded as eliminating linear, quadratic and cubic components in one direction. The mathematical model for the analysis can be regarded equivalently as representing the background of the experimental material against which the experiment is conducted as a curved sheet, the curvatures in vertical planes parallel to the columns (rows) being equal for plots in one row (column). In some situations, however, the changes in the experimental material may be such that different curvatures are more realistic, and on the assumption that the more closely the imposed model represents the underlying phenomena, the greater the achievable accuracy, such alternatives merit consideration.

As usual, a completely general expression of the background material introduces difficulties because of the relation between the number of parameters estimated and the number of degrees of freedom for error, so that some compromise guided by *a priori* knowledge is required, and only the simplest cases have so far been studied.

In one case, for which applications can immediately be envisaged (see below), it is assumed that columns (say) are discrete and that variation within them may be represented in terms of individual linear regressions. The mathematical model used therefore is :

$$y_{ij} = \mu + \varkappa_j + \beta_j a_{ij} + \theta_i + e_{ij}$$

where y_{ij} is the observed value for the experimental unit of the ith treatment in the jth column ; μ is the general mean ; $\varkappa_j$ and β_j are the location and slope parameters for the linear variation in the jth column ; a_{ij} is the discrete row constant for the ith treatment in the jth row measured from a zero mean at the centre of the rows, and it is convenient to take

$$\sum_{i=1}^{n} a^2_{ij} = \sum_{j=1}^{n} a^2_{ij} = n ;$$

θ_i is the ith treatment parameter.

As usual, it is assumed that the unexplained variate e_{ij} is distributed normally and homoscedastically with variance σ^2 about a zero mean.

Unbiased estimates of treatment comparisons can readily be obtained, and the variance – covariance matrix for an $n \times n$ Latin square is

$$-n\,[\mathbf{AA}' - n^2]^{-1}$$

where [A] is the matrix $[a_{ij}]$.

The linearly declining portions of the lactation curves of dairy cattle and goats form the backgrounds for numerous experiments, in some of which treatment after-effects are absent or sufficiently small to permit the application of the preceding analysis. The corresponding analysis of variance on the left in Table 1 is compared with the conventional analysis of a randomization imposed on the lactation curves of four Guernsey cows.

Table 1. Analyses of Variance of Milk yields (lb./week)

Gradient	d.f.	m.s.	Conventional	d.f.	m.s.
Cows	3	8,525·4518	Cows	3	8,525·4518
Regressions ignoring treatments	4	553·3383	Weeks	3	398·7018
Treatments adjusted for regressions	3	35·5477	Treatments	3	86·0976
Unexplained variation	5	39·5352	Unexplained variation	6	177·2123

The treatment estimates for the two methods are :

	$\hat{\theta}_1$	$\hat{\theta}_2$	$\hat{\theta}_3$	$\hat{\theta}_4$
Gradient analysis	−4·97	1·07	0·83	3·08
Conventional analysis	0·55	−2·02	−4·70	6·17

The variance – covariance matrix for the design used is :

$$\frac{1}{4}\begin{bmatrix} 3 & 0 & -1 & 0 \\ 0 & 3 & 0 & -1 \\ -1 & 0 & 3 & 0 \\ 0 & -1 & 0 & 3 \end{bmatrix},$$

so that the variance estimate for differences between two treatments is either 39·54 or 29·65 ; comparison with the corresponding estimate, 88·61, obtained from the conventional analysis shows that in this case a substantial increase in the amount of information has been achieved. The greatest increases in information may be expected when large differences exist between the individual regression coefficients, a situation more likely to occur in animal than in crop experiments, and the gradient analysis may be especially useful when animals from a small herd cannot easily be matched for stage of lactation.

A detailed paper, on the methods discussed here and on the general case allowing for higher-order individual regression terms, is in preparation.

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Feb. 10.

[1] Yates, F., *Emp. J. Exp. Agric.*, **1**, 235 (1933).
[2] Kendall, M. G., "The Advanced Theory of Statistics", **2** (Griffin, 1946).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, June 12

WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY (at St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Prof. R. Hare: "The Transmission of Infections of the Respiratory Tract".* (Almroth Wright Lecture.)

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Wednesday, June 13

INSTITUTE OF METALS (in the Weir Hall of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1), at 6.30 p.m.—Prof. R. Smoluchowski (Carnegie Institute of Technology): "Some Recent Studies of Irradiation Effects in Metals and Other Solids".

Thursday, June 14

COUNCIL FOR THE PRESERVATION OF RURAL ENGLAND (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 2.30 p.m.—Annual General Meeting.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. I. de Burgh Daly, F.R.S.: "The Institute of Animal Physiology, Babraham, Cambridge".

BONE AND TOOTH SOCIETY (at the Institute of Orthopædics, 234 Great Portland Street, London, W.1), at 5 p.m.—Annual General Meeting; followed by "Casual Communications".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Marshall Hall: "Finite Projective Planes".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Prof. Roy P. Foster (U.S.A.): "Active Transport in Cells of Mammalian Renal Tubules Studied *in vitro*".*

Thursday, June 14—Friday, June 15

SOCIETY FOR THE STUDY OF FERTILITY (on Thursday at the Meeting House of the Zoological Society of London, Regent's Park, London, N.W.1, and on Friday at the National Institute for Medical Research, Mill Hill, London), at 10 a.m. daily—Conference.

Friday, June 15

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Gavin de Beer, F.R.S.: "Archæopteryx".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (scientist with experience in initiating projects and co-ordinating the work of research teams under a pre-determined programme) TO THE DIRECTOR OF RESEARCH—The Director of Research, British Food Manufacturing Industries Research Association, Randalls Road, Leatherhead, Surrey, marking envelope "Confidential" (June 13).

CHEMIST (with a first- or good second-class honours degree or equivalent qualification, at least three years experience, and preferably a knowledge of liquid fuels and lubricants) in the Central Laboratory, Chiswick—Recruitment and Training Officer (F/EV. 587), London Transport, 55 Broadway, London, S.W.1 (June 14).

ASSISTANT, Grade B, IN THE PHYSICS DEPARTMENT; and an ASSISTANT, Grade B, TO TEACH BIOLOGY in the Natural Science Department—The Principal, Derby and District College of Technology, Normanton Road, Derby (June 16).

RESEARCH FELLOW IN CHEMISTRY to carry out original work on a radiochemical topic in the Londonderry Laboratory for Radiochemistry; and a RESEARCH STUDENT IN RADIOCHEMISTRY, to undertake original research leading to a higher degree—The Secretary, The University, 38 North Bailey, Durham (June 16).

RESEARCH ASSISTANT IN MATHEMATICAL STATISTICS; and a RESEARCH ASSISTANT IN NUMERICAL ANALYSIS—The Registrar, The University, Liverpool (June 18).

ASSISTANT LECTURER or LECTURER IN ZOOLOGY—The Secretary and Registrar, The University, Southampton (June 20).

LECTURER IN APPLIED MATHEMATICS—The Secretary, The University, 38 North Bailey, Durham (June 20).

LECTURER IN PURE MATHEMATICS—The Secretary, The Queen's University, Belfast (June 20).

RESEARCH FELLOW (graduate, with experience in natural products chemistry) IN CHEMISTRY, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (June 22).

ENGLISH ELECTRIC COMPANY RESEARCH FELLOW IN AERONAUTICS—The Secretary of University Court, The University, Glasgow (June 23).

EXPERIMENTAL OFFICER (agricultural graduate or person with comparable qualifications) at the Dunholme Field Station, Lincoln, to assist in experiments on sugar beet—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (June 23).

SCIENTIFIC OFFICER (with a knowledge of advanced chemistry and postgraduate training in plant physiology) IN THE DEPARTMENT OF PLANT BREEDING, to study developmental physiology of fruit trees, with particular reference to growth and flowering hormones—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (June 23).

RESEARCH ASSISTANT IN PSYCHOLOGY—The Secretary, The University, 38 North Bailey, Durham (June 25).

RESEARCH FELLOW (graduate, with teaching and/or research experience) IN EDUCATION—The Registrar, The University, Bristol (June 25).

ASSISTANT IN PARASITOLOGY—The Assistant Secretary, The University, Edinburgh (June 30).

LECTURER IN PHYSICAL GEOGRAPHY; and a LECTURER IN ECONOMIC GEOGRAPHY, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (June 30).

LECTURER (with special qualifications in physical and/or inorganic chemistry) IN CHEMISTRY in St. Salvator's College—The Joint Clerk to the University Court, College Gate, St. Andrews (June 30).

LECTURERS (3) IN MICROBIOLOGY—The Registrar, The University, Birmingham (June 30).

SENIOR LECTURER or LECTURER (with a degree or equivalent qualification in veterinary medicine) IN ANIMAL HEALTH, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 3).

RESEARCH OFFICER or SENIOR RESEARCH OFFICER (with a university honours degree in science with chemistry as a major subject, postgraduate research experience, and preferably experience in paint technology) IN THE DIVISION OF BUILDING RESEARCH, Commonwealth Scientific and Industrial Research Organization, Highett (near Melbourne), Victoria, Australia, to co-operate with another research officer who will be making a study of the chemical and physical characteristics of fibrous plaster—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 390/238 (July 7).

LECTURER IN ELECTRICAL ENGINEERING; LECTURER IN CIVIL ENGINEERING; and a LECTURER IN MECHANICAL ENGINEERING—The Assistant Secretary, The University, Edinburgh (July 9).

LECTURER IN STATISTICS—The Registrar, The University, Hull (July 11).

LECTURER IN MATHEMATICS at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 15).

LECTURER (with an honours degree and experience in research or in clinical work) IN PSYCHOLOGY, at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 15).

FELLOW (with an honours degree of a British university) IN PHYSICS—The Warden, Merton College, Oxford (July 23)

ASSISTANT KEEPER IN THE DEPARTMENT OF GEOLOGY; and an ASSISTANT KEEPER IN THE DEPARTMENT OF ARCHÆOLOGY—The Secretary, National Museum of Wales, Cardiff (July 28).

LECTURER IN MATHEMATICS at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 31).

LECTURER IN THE DEPARTMENT OF PSYCHOLOGY, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

LECTURER (university graduate in civil engineering and preferably some professional experience, and a specialized knowledge in the theory of structures) IN CIVIL ENGINEERING, at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

LECTURERS or SENIOR LECTURERS (2) IN THE FACULTY OF RURAL SCIENCE, one in Physiology and one in Biochemistry, at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 31).

ASSISTANT (with good academic qualifications and experience in the organization of work programmes at a large industrial laboratory) TO THE DIVISIONAL CHIEF SCIENTIST, West Midlands Division—Divisional Establishment Officer, National Coal Board, Himley Hall, Dudley, Worcs.

BIOCHEMIST (recent graduate) IN THE DEPARTMENT OF CLINICAL RESEARCH, to assist in a research programme relating to certain biochemical aspects of mental illness—The Physician Superintendent, Crichton Royal Mental Hospital, Dumfries.

CONSERVATION OFFICERS (under 30, with a degree in agriculture, agricultural engineering, conservation or pure science, or obtain such a degree in June–July) IN THE DEPARTMENT OF CONSERVATION AND EXTENSION, Ministry of Agriculture, Federation of Rhodesia and Nyasaland, for duties which will consist of advisory work among farmers on all aspects of agricultural production as well as the conservation and utilization of the soil—Federal Public Service Attaché, Rhodesia House, 429 Strand, London, W.C.2.

DEMONSTRATOR or ASSISTANT LECTURER IN BOTANY in the Department of Biological Sciences—The Registrar, Wye College, near Ashford, Kent.

DEMONSTRATORS IN (*a*) AGRICULTURAL BOTANY (preferably with an interest in plant physiology); (*b*) MICROBIOLOGY (with an interest in dairying or soil microbiology); (*c*) AGRICULTURAL CHEMISTRY (with qualifications in agricultural chemistry); and (*d*) AGRICULTURAL ZOOLOGY (with qualifications in agricultural zoology or zoology)—The Registrar, The University, Nottingham.

EXPERIMENTAL OFFICER (male, with a degree in engineering or physics or H.N.C. in electrical or mechanical engineering, or equivalent qualifications, and experience in instrumentation, especially servo mechanisms or computing, and preferably a knowledge of guided weapon control techniques), at the Royal Military College of Science, Shrivenham, Berkshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting Ref. D.38/6A.

GENETICIST, Scientific Officer grade (with some research experience and an interest in quantitative genetics), to work with mice on prob-

lems related to animal breeding—The Director, Institute of Animal Genetics, West Mains Road, Edinburgh 9.

Laboratory Technician (Zoology) (with some knowledge of biological techniques and/or experience in the use of laboratory apparatus)—The Registrar (ZT), Queen Mary College (University of London), Mile End Road, London, E.1.

Lecturer (preferably honours graduate with industrial experience) in Inorganic Chemistry—The Principal, Medway College of Technology, Horsted, Maidstone Road, Chatham, Kent.

Lecturer (with a good degree, and preferably industrial experience) in Metallurgy—The Secretary, Royal Technical College, Glasgow.

Non-Medical Biochemist, Basic grade (with a university degree in biochemistry or A.R.I.C.), to work under the Consultant Biochemist—The Hospital Secretary, Paddington General Hospital and Group Laboratory, Harrow Road, London, W.9.

Research Assistant (female, with a degree in chemistry or physics, and an interest in the physical chemistry of biological systems)—The Secretary, The Research Institute (Animal Virus Diseases), Pirbright, Surrey.

Research Assistant (Ph.D. standard), for work on the physical absorption of vapours on ionic crystals—Dr. F. C. Tompkins, F.R.S., Imperial College of Science and Technology, London, S.W.7.

Research Lecturer or Assistant Lecturer in Statistics—The Registrar, The University, Nottingham.

Research Students to work on problems relating to atmospherics—Meteorology Section, Cavendish Laboratory, Cambridge.

Scientific Officer (with a first- or second-class honours degree) for laboratory work on physical and engineering problems associated with the use of new techniques in crop conservation—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds.

Senior Lecturer or Lecturer (with a special interest in inorganic chemistry) in Chemistry, at the University College of Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

Senior Technical Assistant for development work in the Bacteriological Laboratory—Prof. Todd, Royal Technical College, Glasgow.

Student Technician (male or female) in the Pathological Laboratory—The Secretary, Wembley Hospital, Wembley, Middlesex.

Superintendent Physicist (with high qualifications in physics and a wide experience of explosive shock phenomena, and preferably some experience in the study of transient electrical phenomena), to lead a team in the study of shock excitation of materials to high temperatures—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. No. 1141/34.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Report of a Committee of Enquiry. Pp. 4. (Cmd. 9734.) (London: H.M. Stationery Office, 1956.) 4*d*. net. [54

National Research Development Corporation. Report and Statement of Accounts for the year 1st July, 1954 to 30th June, 1955. Pp. ii+20. (London: H.M. Stationery Office, 1956.) 1*s*. net. [54

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Notas de Física. Vol. 2, No. 2: The Photonuclear Effect and the Complex Potential-Well Nuclear Model. By J. P. Davidson. Pp. 6. Vol. 2, No. 4: Shell Effect on Photonuclear Reactions. By J. Goldemberg and J. Leite Lopes. Pp. 7. Vol. 2, No. 5: Note on the Non-Relativistic Equation for Spin ½ and 1 Particles with Anomalous Magnetic Moment. By J. J. Giambiagi. Pp. 10. Vol. 2, No. 6: Relativistic Theory of Spinning Point Particles. By J. Tiomno. Pp. 20. Vol. 2, No. 7: The Formation of P^{32} from Atmospheric Argon by Cosmic Rays. By L. Marques and Neyla L. Costa. Pp. 8. (Rio de Janeiro: Centro Brasileiro de Pasquisas Fisicas, 1955.) [64

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Uganda Electricity Board. Eighth Annual Report and Accounts for the year ended 31st December, 1955. Pp. 48. (Kampala: Uganda Electricity Board, 1956.) Shs. 1. [64

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